DEPARTMENT OF THE NAVY (DON)
25.2 Small Business Innovation Research (SBIR)
Phase I Proposal Submission Instructions

IMPORTANT

- **The following instructions apply to topics:**
  - **N252-074 through N252-121**

- Submitting small business concerns are encouraged to thoroughly review the DoD SBIR/STTR Program Broad Agency Announcement (BAA) and register for the DSIP Listserv to remain apprised of important programmatic changes.
  - The DoD Program BAA is located at: https://www.dodsbirsttr.mil/submissions/login. Select the tab for the appropriate BAA cycle.
  - Register for the DSIP Listserv at: https://www.dodsbirsttr.mil/submissions/login.

- The information provided in the DON Proposal Submission Instructions takes precedence over the DoD Instructions posted for this BAA.

- **DON Phase I Technical Volume (Volume 2) page limit is not to exceed 10 pages.**

- Proposing small business concerns that are more than 50% owned by multiple venture capital operating companies (VCOC), hedge funds (HF), private equity firms (PEF) or any combination of these are eligible to submit proposals in response to DON topics advertised in this BAA. Information on Majority Ownership in Part and certification requirements at time of submission for these proposing small business concerns are detailed in the section titled ADDITIONAL SUBMISSION CONSIDERATIONS.

- Phase I Technical Volume (Volume 2) and Supporting Documents (Volume 5) templates, specific to DON topics, are available at https://www.navysbir.com/links_forms.htm.

- The DON provides notice that Basic Ordering Agreements (BOAs) may be used for Phase I awards, and BOAs or Other Transaction Agreements (OTAs) may be used for Phase II awards.

- This BAA is issued under regulations set forth in Federal Acquisition Regulation (FAR) 35.016 and awards will be made under "other competitive procedures". The policies and procedures of FAR Subpart 15.3 shall not apply to this BAA, except as specifically referenced in it. All procedures are at the sole discretion of the Government as set forth in this BAA. Submission of a proposal in response to this BAA constitutes the express acknowledgement to that effect by the proposing small business concern.

INTRODUCTION

The DON SBIR/STTR Programs are mission-oriented programs that integrate the needs and requirements of the DON's Fleet through research and development (R&D) topics that have dual-use potential, but primarily address the needs of the DON. More information on the programs can be found on the DON SBIR/STTR website at www.navysbir.com. Additional information on DON's mission can be found on the DON website at www.navy.mil.

For questions regarding this BAA, use the information in Table 1 to determine who to contact for what types of questions.

TABLE 1: POINTS OF CONTACT FOR QUESTIONS REGARDING THIS BAA

Type of Question	When	Contact Information
Program and administrative	Always	Navy SBIR/STTR Program Management Office usn.pentagon.cnr-arlington-va.mbx.navy-sbir-sttr@us.navy.mil or appropriate Program Manager listed in Table 2 (below)
Topic-specific technical questions	BAA Pre-release	Technical Point of Contact (TPOC) listed in each topic on the DoD SBIR/STTR Innovation Portal (DSIP). Refer to the Proposal Submission section of the DoD SBIR/STTR Program BAA for details.
	BAA Open	DoD SBIR/STTR Topic Q&A platform (https://www.dodsbirsttr.mil/submissions) Refer to the Proposal Submission section of the DoD SBIR/STTR Program BAA for details.
Electronic submission to the DoD SBIR/STTR Innovation Portal (DSIP)	Always	DSIP Support via email at dodsbirsupport@reisystems.com
Navy-specific BAA instructions and forms	Always	DON SBIR/STTR Program Management Office usn.pentagon.cnr-arlington-va.mbx.navy-sbir-sttr@us.navy.mil

TABLE 2: DON SYSTEMS COMMANDS (SYSCOM) SBIR PROGRAM MANAGERS

Topic Numbers	Point of Contact	SYSCOM	Email
N252-074 to N252-078	Mr. Jeffrey Kent	Marine Corps Systems Command (MCSC)	smb_mcsc_sbir_admins@usmc.mil
N252-079 to N252-094	Ms. Kristi DePriest	Naval Air Systems Command (NAVAIR)	navair-sbir@us.navy.mil
N252-095 to N252-098	Mr. Jason Schroepfer	Naval Sea Systems Command (NAVSEA)	NSSC_SBIR.fct@navy.mil
N252-099 to N252-113	Ms. Lore-Anne Ponirakis	Office of Naval Research (ONR)	usn.pentagon.cnr-arlington-va.mbx.onr-sbir-sttr@us.navy.mil
N252-114 to N252-121	Dr. Scott Steward	Strategic Systems Programs (SSP)	ssp.sbir@ssp.navy.mil

PHASE I SUBMISSION INSTRUCTIONS

The following section details requirements for submitting a compliant Phase I proposal to the DoD SBIR/STTR Programs.

(NOTE: Proposing small business concerns are advised that support contract personnel will be used to carry out administrative functions and may have access to proposals, contract award documents, contract deliverables, and reports. All support contract personnel are bound by appropriate non-disclosure agreements.)

DoD SBIR/STTR Innovation Portal (DSIP). Proposing small business concerns are required to submit proposals via the DoD SBIR/STTR Innovation Portal (DSIP); and follow proposal submission instructions in the DoD SBIR/STTR Program BAA on the DSIP at https://www.dodsbirsttr.mil/submissions. Proposals submitted by any other means will be disregarded. Proposing small business concerns submitting through DSIP for the first time will be asked to register. It is recommended that small business concerns register as soon as possible upon identification of a proposal opportunity to avoid delays in the proposal submission process. Proposals that are not successfully certified electronically in DSIP by the Corporate Official prior to BAA Close will NOT be considered submitted and will not be evaluated by DON. Proposals that are encrypted, password protected, or otherwise locked in any portion of the submission will be REJECTED unless specifically directed within the text of the topic to which you are submitting. Please refer to the DoD SBIR/STTR Program BAA for further information.

Proposal Volumes. The following seven volumes are required.

- **Proposal Cover Sheet (Volume 1).** As specified in DoD SBIR/STTR Program BAA.

- **Technical Proposal (Volume 2)**
  - Technical Proposal (Volume 2) must meet the following requirements or the proposal will be REJECTED:
    - Not to exceed ten (10) pages, regardless of page content
    - Single column format, single-spaced typed lines
    - Standard 8 ½” x 11” paper
    - Page margins one inch on all sides. A header and footer may be included in the one-inch margin.
    - No font size smaller than 10-point
    - Include, within the ten-page limit of Volume 2, an Option that furthers the effort in preparation for Phase II and will bridge the funding gap between the end of Phase I and the start of Phase II. Tasks for both the Phase I Base and the Phase I Option must be clearly identified. Phase I Options are exercised upon selection for Phase II.
    - Work proposed for the Phase I Base must be exactly six (6) months.
    - Work proposed for the Phase I Option must be exactly six (6) months.

  - Additional information:
    - A Phase I proposal template specific to DON to meet Phase I requirements is available at https://navysbir.com/links_forms.htm
    - A font size smaller than 10-point is allowable for headers, footers, imbedded tables, figures, images, or graphics that include text. However, proposing small business concerns are cautioned that if the text is too small to be legible it will not be evaluated.

- **Cost Volume (Volume 3).**
  - Cost Volume (Volume 3) must meet the following requirements or the proposal will be REJECTED:
    - The Phase I Base amount must not exceed $140,000.
    - Phase I Option amount must not exceed $100,000.
    - Costs for the Base and Option must be separated and clearly identified on the Proposal Cover Sheet (Volume 1) and in Volume 3.
    - For Phase I, a minimum of two-thirds of the work is performed by the proposing small business concern. The two-thirds percentage of work requirement must be met in the Base costs as well as in the Option costs. DON will not accept deviations from the minimum percentage of work requirements for Phase I. The percentage of work is measured by both direct and indirect costs. To calculate the minimum percentage of work for the proposing small business concern the sum of all direct and indirect costs attributable to the proposing small business concern represent the numerator and the total cost of the proposal (i.e., Total Cost before Profit Rate is applied) is the denominator. The subcontractor percentage is calculated by taking the sum of all costs attributable to the subcontractor (Total Subcontractor Costs (TSC)) as the numerator and the total cost of the proposal (i.e., Total Cost before Profit Rate is applied) as the denominator.
      - Proposing Small Business Concern Costs (included in numerator for calculation of the small business concern):
        - Total Direct Labor (TDL)
        - Total Direct Material Costs (TDM)
        - Total Direct Supplies Costs (TDS)
        - Total Direct Equipment Costs (TDE)
        - Total Direct Travel Costs (TDT)
        - Total Other Direct Costs (TODC)
        - General & Administrative Cost (G&A)

        NOTE: G&A, if proposed, will only be attributed to the proposing small business concern.
      - Subcontractor Costs (numerator for subcontractor calculation):
        - Total Subcontractor Costs (TSC)
      - Total Cost (i.e., Total Cost before Profit Rate is applied, denominator for either calculation)
    - **Cost Sharing: Cost sharing is not accepted on DON Phase I proposals. If a value above or below $0.00 is entered in the Cost Sharing field the proposal will be deemed non-compliant and will be REJECTED by DON.**

  - Additional information:
    - Provide sufficient detail for subcontractor, material, and travel costs. Subcontractor costs must be detailed to the same level as the prime contractor. Material costs must include a listing of items and cost per item. Travel costs must include the purpose of the trip, number of trips, location, length of trip, and number of personnel.
    - Inclusion of cost estimates for travel to the sponsoring SYSCOM's facility for one day of meetings is recommended for all proposals.
    - The "Additional Cost Information" of Supporting Documents (Volume 5) may be used to provide supporting cost details for Volume 3. When a proposal is selected for award, be prepared to submit further documentation to the SYSCOM Contracting Officer to substantiate costs (e.g., an explanation of cost estimates for equipment, materials, and consultants or subcontractors).

- **Company Commercialization Report (Volume 4)**. DoD collects and uses Volume 4 and DSIP requires Volume 4 for proposal submission. Please refer to the Proposal Preparation Instructions and Requirements section of the DoD SBIR/STTR Program BAA for details to ensure compliance with DSIP Volume 4 requirements.

- **Supporting Documents (Volume 5).** Volume 5 is for the submission of administrative material that DON may or will require to process a proposal, if selected, for contract award.

  - Proposing small business concerns must review and submit the following items, as applicable:
    - **Majority Ownership in Part.** Proposing small business concerns that are more than 50% owned by multiple venture capital operating companies (VCOC), hedge funds (HF), private equity firms (PEF), or any combination of these as set forth in 13 C.F.R. § 121.702, are eligible to submit proposals in response to DON topics advertised within this BAA. Complete the certification as detailed under ADDITIONAL SUBMISSION CONSIDERATIONS.

  - Additional information:
    - Proposing small business concerns may include the following administrative materials in Supporting Documents (Volume 5); a template is available at https://navysbir.com/links_forms.htm to provide guidance on optional material the proposing small business concern may want to include in Volume 5:
      - Additional Cost Information to support the Cost Volume (Volume 3)
      - SBIR/STTR Funding Agreement Certification
      - Data Rights Assertion
      - Disclosure of Information (DFARS 252.204-7000)
      - Prior, Current, or Pending Support of Similar Proposals or Awards
      - Foreign Citizens
    - Details of Request for Discretionary Technical and Business Assistance (TABA), if proposed, is to be included under the Additional Cost Information section if using the DON Supporting Documents template.
    - Do not include documents or information to substantiate the Technical Volume (Volume 2) in Volume 5 (e.g., resumes, test data, technical reports, or publications). Such documents or information will not be considered.
    - A font size smaller than 10-point is allowable for documents in Volume 5; however, proposing small business concerns are cautioned that the text may be unreadable.

- **Fraud, Waste and Abuse Training Certification (Volume 6)**. DoD requires Volume 6 for submission. Please refer to the Proposal Preparation Instructions and Requirements section of the DoD SBIR/STTR Program BAA for details.

- **Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Volume 7)**. In accordance with Section 4 of the SBIR and STTR Extension Act of 2022 and the SBA SBIR/STTR Policy Directive, the DoD will review all proposals submitted in response to this BAA to assess security risks presented by small business concerns seeking a Federally funded award. Small business concerns must complete the Disclosures of Foreign Affiliations or Relationships to Foreign Countries webform in Volume 7 of the DSIP proposal submission. Please refer to the Proposal Preparation Instructions and Requirements section of the DoD SBIR/STTR Program BAA for details.

PHASE I EVALUATION AND SELECTION

The following section details how the DON SBIR/STTR Programs will evaluate Phase I proposals.

Proposals meeting DSIP submission requirements will be forwarded to the DON SBIR/STTR Programs. Prior to evaluation, all proposals will undergo a compliance review to verify compliance with DoD and DON SBIR/STTR proposal eligibility requirements. Proposals not meeting submission requirements will be REJECTED and not evaluated.

- **Proposal Cover Sheet (Volume 1).** The Proposal Cover Sheet (Volume 1) will undergo a compliance review to verify the proposing small business concern has met eligibility requirements and followed the instructions for the Proposal Cover Sheet as specified in the DoD SBIR/STTR Program BAA.

- **Technical Volume (Volume 2).** The DON will evaluate and select Phase I proposals using the evaluation criteria specified in the Method of Selection and Evaluation Criteria section of the DoD SBIR/STTR Program BAA, with technical merit being most important, followed by qualifications of key personnel and commercialization potential of equal importance. The information considered for this decision will come from Volume 2. This is not a FAR Part 15 evaluation and proposals will not be compared to one another. Cost is not an evaluation criterion and will not be considered during the evaluation process; the DON will only do a compliance review of Volume 3. Due to limited funding, the DON reserves the right to limit the number of awards under any topic.

  The Technical Volume (Volume 2) will undergo a compliance review (prior to evaluation) to verify the proposing small business concern has met the following requirements or the proposal will be REJECTED:
  - Not to exceed ten (10) pages, regardless of page content
  - Single column format, single-spaced typed lines
  - Standard 8 ½” x 11” paper
  - Page margins one inch on all sides. A header and footer may be included in the one-inch margin.
  - No font size smaller than 10-point, except as permitted in the instructions above.
  - Include, within the 10-page limit of Volume 2, an Option that furthers the effort in preparation for Phase II and will bridge the funding gap between the end of Phase I and the start of Phase II. Tasks for both the Phase I Base and the Phase I Option must be clearly identified.
  - Work proposed for the Phase I Base must be exactly six (6) months.
  - Work proposed for the Phase I Option must be exactly six (6) months.

- **Cost Volume (Volume 3).** The Cost Volume (Volume 3) will not be considered in the selection process and will only undergo a compliance review to verify the proposing small business concern has met the following requirements or the proposal will be REJECTED:
  - Must not exceed values for the Base ($140,000) and Option ($100,000).
  - Must meet minimum percentage of work; a minimum of two-thirds of the work is performed by the proposing small business concern. The two-thirds percentage of work requirement must be met in the Base costs as well as in the Option costs. DON will not accept deviations from the minimum percentage of work requirements for Phase I.
  - **Cost Sharing: Cost sharing is not accepted on DON Phase I proposals. If a value above or below $0.00 is entered in the Cost Sharing field the proposal will be deemed non-compliant and will be REJECTED by DON.**

- **Company Commercialization Report (CCR) (Volume 4).** The CCR (Volume 4) will not be evaluated by the DON nor will it be considered in the award decision. However, all proposing small business concerns must refer to the DoD SBIR/STTR Program BAA to ensure compliance with DSIP Volume 4 requirements.

- **Supporting Documents (Volume 5).** Supporting Documents (Volume 5) will not be considered in the selection process and will only undergo a compliance review to ensure the proposing small business concern has included items in accordance with the PHASE I SUBMISSION INSTRUCTIONS section above.

- **Fraud, Waste, and Abuse Training Certificate (Volume 6).** Not evaluated.

- **Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Volume 7)**. Disclosures of Foreign Affiliations or Relationships to Foreign Countries (Volume 7) will be assessed as part of the Due Diligence Program to Assess Security Risks. Refer to the DoD SBIR/STTR Program BAA to ensure compliance with Volume 7 requirements.

ADDITIONAL SUBMISSION CONSIDERATIONS

This section details additional items for proposing small business concerns to consider during proposal preparation and submission process.

Due Diligence Program to Assess Security Risks. The SBIR and STTR Extension Act of 2022 (Pub. L. 117-183) requires the Department of Defense, in coordination with the Small Business Administration, to establish and implement a due diligence program to assess security risks presented by small business concerns seeking a Federally-funded award. Please review the Certifications and Registrations section of the DoD SBIR/STTR Program BAA for details on how DoD will assess security risks presented by small business concerns. The Due Diligence Program to Assess Security Risks will be implemented for all Phases.

Discretionary Technical and Business Assistance (TABA). The SBIR and STTR Policy Directive section 9(b) allows the DON to provide TABA (formerly referred to as DTA) to its awardees. The purpose of TABA is to assist awardees in making better technical decisions on SBIR/STTR projects; solving technical problems that arise during SBIR/STTR projects; minimizing technical risks associated with SBIR/STTR projects; and commercializing the SBIR/STTR product or process, including intellectual property protections. Proposing small business concerns may request, in their Phase I Cost Volume (Volume 3) and Phase II Cost Volume, to contract these services themselves through one or more TABA providers in an amount not to exceed the values specified below. The Phase I TABA amount is up to $6,500 and is in addition to the award amount. The Phase II TABA amount is up to $25,000 per award, is to be included as part of the award amount, and is limited by the established award values for Phase II by the SYSCOM (i.e., within the $2,000,000 or lower limit specified by the SYSCOM). As with Phase I, the amount proposed for TABA cannot include any profit/fee by the proposing small business concern and must be inclusive of all applicable indirect costs. TABA cannot be used in the calculation of general and administrative expenses (G&A) for the SBIR proposing small business concern. A Phase II project may receive up to an additional $25,000 for TABA as part of one additional (sequential) Phase II award under the project for a total TABA award of up to $50,000 per project. A small business concern receiving TABA will be required to submit a report detailing the results and benefits of the service received. This TABA report will be due at the time of submission of the final report.

Request for TABA funding will be reviewed by the DON SBIR/STTR Program Management Office.

If the TABA request does not include the following items the TABA request will be denied.

- TABA provider(s) (firm name)
- TABA provider(s) point of contact, email address, and phone number
- An explanation of why the TABA provider(s) is uniquely qualified to provide the service
- Tasks the TABA provider(s) will perform (to include the purpose and objective of the assistance)
- Total TABA provider(s) cost, number of hours, and labor rates (average/blended rate is acceptable)

TABA must NOT:

- Be subject to any indirect costs, profit, or fee by the SBIR proposing small business concern
- Propose a TABA provider that is the SBIR proposing small business concern
- Propose a TABA provider that is an affiliate of the SBIR proposing small business concern
- Propose a TABA provider that is an investor of the SBIR proposing small business concern
- Propose a TABA provider that is a subcontractor or consultant of the requesting small business concern otherwise required as part of the paid portion of the research effort (e.g., research partner, consultant, tester, or administrative service provider)

TABA requests must be included in the proposal as follows:

- Phase I:
    - Online DoD Cost Volume (Volume 3) – the value of the TABA request.
    - Supporting Documents (Volume 5) – a detailed request for TABA (as specified above) specifically identified as "TABA" in the section titled Additional Cost Information when using the DON Supporting Documents template.
- Phase II:
    - DON Phase II Cost Volume (provided by the DON SYSCOM) - the value of the TABA request.
    - Supporting Documents (Volume 5) – a detailed request for TABA (as specified above) specifically identified as "TABA" in the section titled Additional Cost Information when using the DON Supporting Documents template.

Proposed values for TABA must NOT exceed:

- Phase I: A total of $6,500
- Phase II: A total of $25,000 per award, not to exceed $50,000 per Phase II project

If a proposing small business concern requests and is awarded TABA in a Phase II contract, the proposing small business concern will be eliminated from participating in the Navy SBIR Transition Program (STP), the DON Forum for SBIR/STTR Transition (FST), and any other Phase II assistance the DON provides directly to awardees.

All Phase II awardees not receiving funds for TABA in their awards must participate in the virtual Navy STP Kickoff during the first or second year of the Phase II contract. While there are no travel costs associated with this virtual event, Phase II awardees should budget time of up to a full day to participate. STP information can be obtained at: https://navystp.com. Phase II awardees will be contacted separately regarding this program.

Disclosure of Information (DFARS 252.204-7000). In order to eliminate the requirements for prior approval of public disclosure of information (in accordance with DFARS 252.204-7000) under this award, the proposing small business concern shall identify and describe all fundamental research to be performed under its proposal, including subcontracted work, with sufficient specificity to demonstrate that the work qualifies as fundamental research. Fundamental research means basic and applied research in science and engineering, the results of which ordinarily are published and shared broadly within the scientific community, as distinguished from proprietary research and from industrial development, design, production, and product utilization, the results of which ordinarily are restricted for proprietary or national security reasons (defined by National Security Decision Directive 189). A small business concern whose proposed work will include fundamental research and requests to eliminate the requirement for prior approval of public disclosure of information must complete the DON Fundamental Research Disclosure and upload as a separate PDF file to the Supporting Documents (Volume 5) in DSIP as part of their proposal submission. The DON Fundamental Research Disclosure is available on https://navysbir.com/links_forms.htm and includes instructions on how to complete and upload the completed Disclosure. Simply identifying fundamental research in the Disclosure does **NOT** constitute acceptance of the exclusion. All exclusions will be reviewed and, if approved by the Government Contracting Officer, noted in the contract.

Majority Ownership in Part. Proposing small business concerns that are more than 50% owned by multiple venture capital operating companies (VCOC), hedge funds (HF), private equity firms (PEF), or any combination of these as set forth in 13 C.F.R. § 121.702, **are eligible** to submit proposals in response to DON topics advertised within this BAA.

For proposing small business concerns that are a member of this ownership class the following must be satisfied for proposals to be accepted and evaluated:

a. Prior to submitting a proposal, small business concerns must register with the SBA Company Registry Database.
b. The proposing small business concern within its submission must submit the Majority-Owned VCOC, HF, and PEF Certification. A copy of the SBIR VC Certification can be found on https://navysbir.com/links_forms.htm. Include the SBIR VC Certification in the Supporting Documents (Volume 5).
c. Should a proposing small business concern become a member of this ownership class after submitting its proposal and prior to any receipt of a funding agreement, the proposing small business concern must immediately notify the Contracting Officer, register in the appropriate SBA database, and submit the required certification, which can be found on https://navysbir.com/links_forms.htm.

System for Award Management (SAM). It is strongly encouraged that proposing small business concerns register in SAM, https://sam.gov, by the Close date of this BAA, or verify their registrations are still active and will not expire within 60 days of BAA Close. Additionally, proposing small business concerns should confirm that they are registered to receive contracts (not just grants) and the address in SAM matches the address on the proposal. A small business concern selected for an award MUST have an active SAM registration at the time of award or they will be considered ineligible.

Notice of NIST SP 800-171 Assessment Database Requirement. The purpose of the National Institute of Standards and Technology (NIST) Special Publication (SP) 800-171 is to protect Controlled Unclassified Information (CUI) in Nonfederal Systems and Organizations. As prescribed by DFARS 252.204-7019, in order to be considered for award, a small business concern is required to implement NIST SP 800-171 and shall have a current assessment uploaded to the Supplier Performance Risk System (SPRS) which provides storage and retrieval capabilities for this assessment. The platform Procurement Integrated Enterprise Environment (PIEE) will be used for secure login and verification to access SPRS. For brief instructions on NIST SP 800-171 assessment, SPRS, and PIEE, please visit https://www.sprs.csd.disa.mil/nistsp.htm. For in-depth tutorials on these items, please visit https://www.sprs.csd.disa.mil/webtrain.htm.

Human Subjects, Animal Testing, and Recombinant DNA. Due to the short timeframe associated with Phase I of the SBIR/STTR process, the DON does **not** recommend the submission of Phase I proposals that require the use of Human Subjects, Animal Testing, or Recombinant DNA. For example, the ability to obtain Institutional Review Board (IRB) approval for proposals that involve human subjects can take 6-12 months, and that lengthy process can be at odds with the Phase I goal for time-to-award. Before the DON makes any award that involves an IRB or similar approval requirement, the proposing small business concern must demonstrate compliance with relevant regulatory approval requirements that pertain to proposals involving human, animal, or recombinant DNA protocols. It will not impact the DON's evaluation, but requiring IRB approval may delay the start time of the Phase I award and if approvals are not obtained within two months of notification of selection, the decision to award may be terminated. If the use of human, animal, and recombinant DNA is included under a Phase I or Phase II proposal, please carefully review the requirements at: https://www.nre.navy.mil/work-with-us/how-to-apply/compliance-and-protections/research-protections. This webpage provides guidance and lists approvals that may be required before contract/work can begin.

Government Furnished Equipment (GFE). Due to the typical lengthy time for approval to obtain GFE, it is recommended that GFE is not proposed as part of the Phase I proposal. If GFE is proposed, and it is determined during the proposal evaluation process to be unavailable, proposed GFE may be considered a weakness in the technical merit of the proposal.

International Traffic in Arms Regulation (ITAR). For topics indicating ITAR restrictions or the potential for classified work, limitations are generally placed on disclosure of information involving topics of a classified nature or those involving export control restrictions, which may curtail or preclude the involvement of universities and certain non-profit institutions beyond the basic research level. Small businesses must structure their proposals to clearly identify the work that will be performed that is of a basic research nature and how it can be segregated from work that falls under the classification and export control restrictions. As a result, information must also be provided on how efforts can be performed in later phases if the university/research institution is the source of critical knowledge, effort, or infrastructure (facilities and equipment).

SELECTION, AWARD, AND POST-AWARD INFORMATION

Notifications. Email notifications for proposal receipt (approximately one week after the Phase I BAA Close) and selection are sent based on the information received on the proposal Cover Sheet (Volume 1). Consequently, the e-mail address on the proposal Cover Sheet must be correct.

Debriefs. Requests for a debrief must be made within 15 calendar days of select/non-select notification via email as specified in the select/non-select notification. Please note debriefs are typically provided in writing via email to the Corporate Official identified in the proposal of the proposing small business concern within 60 days of receipt of the request. Requests for oral debriefs may not be accommodated. If contact information for the Corporate Official has changed since proposal submission, a notice of the change on company letterhead signed by the Corporate Official must accompany the debrief request.

Protests. Interested parties have the right to protest in accordance with the procedures in FAR Subpart 33.1.

Pre-award agency protests related to the terms of the BAA must be served to: osd.ncr.ousd-r-e.mbx.SBIR-STTR-Protest@mail.mil. A copy of a pre-award Government Accountability Office (GAO) protest must also be filed with the aforementioned email address within one day of filing with the GAO.

Protests related to a selection or award decision should be filed with the appropriate Contracting Officer for an Agency Level Protest or with the GAO. Contracting Officer contact information for specific DON Topics may be obtained from the DON SYSCOM Program Managers listed in Table 2 above. For protests filed with the GAO, a copy of the protest must be submitted to the appropriate DON SYSCOM Program Manager and the appropriate Contracting Officer within one day of filing with the GAO.

Awards. Due to limited funding, the DON reserves the right to limit the number of awards under any topic. Any notification received from the DON that indicates the proposal has been selected does not ultimately guarantee an award will be made. This notification indicates that the proposal has been selected in accordance with the evaluation criteria and has been sent to the Contracting Officer to conduct compliance review of Volume 3 to confirm eligibility of the proposing small business concern, and to take other relevant steps necessary prior to making an award.

Contract Types. The DON typically awards a Firm Fixed Price (FFP) contract or a small purchase agreement for Phase I. In addition to the negotiated contract award types listed in the section of the DoD SBIR/STTR Program BAA titled Additional Considerations, for Phase II awards the DON may (under appropriate circumstances) propose the use of an Other Transaction Agreement (OTA) as specified in 10 U.S.C. 4021/10 U.S.C. 4022 and related implementing policies and regulations. The DON may choose to use a Basic Ordering Agreement (BOA) for Phase I and Phase II awards.

Funding Limitations. In accordance with the SBIR and STTR Policy Directive section 4(b)(5), there is a limit of one sequential Phase II award per small business concern per topic. The maximum Phase I proposal/award amount including all options is $240,000. The Phase I Base amount must not exceed $140,000 and the Phase I Option amount must not exceed $100,000. The maximum Phase II proposal/award amount including all options (including TABA) is $2,000,000 (unless non-SBIR/STTR funding is being added). Individual SYSCOMs may award amounts, including Base and all Options, of less than $2,000,000 based on available funding. The structure of the Phase II proposal/award, including maximum amounts as well as breakdown between Base and Option amounts will be provided to all Phase I awardees either in their Phase I award or a minimum of 30 days prior to the due date for submission of their Initial Phase II proposal.

Contract Deliverables. Contract deliverables for Phase I are typically a kick-off brief, progress reports, and a final report. Required contract deliverables (as stated in the contract) must be uploaded to https://www.navysbirprogram.com/navydeliverables/.

Payments. The DON makes three payments from the start of the Phase I Base period, and from the start of the Phase I Option period, if exercised. Payment amounts represent a set percentage of the Base or Option value as follows:

Days from Start of Base Award or Option	Payment Amount
15 Days	50% of Total Base or Option
90 Days	35% of Total Base or Option
180 Days	15% of Total Base or Option

Transfer Between SBIR and STTR Programs. Section 4(b)(1)(i) of the SBIR and STTR Policy Directive provides that, at the agency's discretion, projects awarded a Phase I under a BAA for SBIR may transition in Phase II to STTR and vice versa.

PHASE II GUIDELINES

Evaluation and Selection. All Phase I awardees may submit an **Initial** Phase II proposal for evaluation and selection. The evaluation criteria for Phase II is the same as Phase I (as stated in this BAA). The Phase I Final Report and Initial Phase II Proposal will be used to evaluate the small business concern's potential to progress to a workable prototype in Phase II and transition the technology to Phase III. Details on the due date, content, and submission requirements of the Initial Phase II Proposal will be provided by the awarding SYSCOM either in the Phase I contract or by subsequent notification.

Awards. The DON typically awards a Cost Plus Fixed Fee contract for Phase II; but, may consider other types of agreement vehicles. Phase II awards can be structured in a way that allows for increased funding levels based on the project's transition potential. To accelerate the transition of SBIR/STTR-funded technologies to Phase III, especially those that lead to Programs of Record and fielded systems, the Commercialization Readiness Program was authorized and created as part of section 5122 of the National Defense Authorization Act of Fiscal Year 2012. The statute set-aside is 1% of the available SBIR/STTR funding to be used for administrative support to accelerate transition of SBIR/STTR-developed technologies and provide non-financial resources for the small business concerns (e.g., the Navy STP).

PHASE III GUIDELINES

A Phase III SBIR/STTR award is any work that derives from, extends, or completes effort(s) performed under prior SBIR/STTR funding agreements, but is funded by sources other than the SBIR/STTR programs. This covers any contract, grant, or agreement issued as a follow-on Phase III award or any contract, grant, or agreement award issued as a result of a competitive process where the awardee was an SBIR/STTR firm that developed the technology as a result of a Phase I or Phase II award. The DON will give Phase III status to any award that falls within the above-mentioned description. Consequently, DON will assign SBIR/STTR Data Rights to any noncommercial technical data and noncommercial computer software delivered in Phase III that were developed under SBIR/STTR Phase I/II effort(s). Government prime contractors and their subcontractors must follow the same guidelines as above and ensure that companies operating on behalf of the DON protect the rights of the SBIR/STTR firm.

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N252-074 TITLE: Materials Optimization for 81mm M299 Ignition Cartridge System

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Sustainment

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a suitable material that meets the M299 Ignition Cartridge (IC) Tube Assembly Technical Data Package (TDP) requirements and an engineering solution to optimize the current design while aligning with historical pressure characteristics and current range precision requirements.

DESCRIPTION: The current M299 IC system consists of the following critical components:

a. Flash Tube Assembly
b. Tube Assembly
c. Firing Plug
d. Head
e. Black Powder Pellet
f. Primer 150D
g. Body (drawing 9293428)
h. Cap (drawing 9294756)

The Tube Assembly contains the Tube as the base structure and the Heat Shrinkable Tubing that is applied to the exterior. The current Tube material is a sulfate paper produced using the Kraft wood pulping process and coated with paraffin wax. The current configuration of the Tube is spiral wound such that each layer of the Cartridge Paper is secured with adhesive. The Tube Assembly is positioned over the Flash Tube Assembly, secured to the IC body with adhesive, loaded with M9 flake propellant, and sealed with the Cap and applied adhesive.

The current Tube dimensions are 4.770 +/- 0.015 inches in length, an inner diameter of 0.562 +0.005/-0.000 inches, and a thickness of 0.041 +0.000/-0.010 inches. These dimensions are required to ensure there is proper spacing within the ignition cartridge to provide a cavity for the propellant.

The M299 IC specification (MIL-DTL-32247) allows for a wide range in Tube bursting strength. MIL-DTL-32247 paragraph 3.11 defines the bursting strength requirement as the following:

a. “The tube shall not burst at a compression load of 57 pounds, minimum, but shall burst at a compression load of 192 pounds, maximum.

However, the Army is currently analyzing historical test data to optimize pressure characteristics and tighten the bursting strength requirement. Variation in the Tube wall thickness directly affects bursting strength and therefore the pressure characteristics during the IC deflagration event. IC paper tube materials, design, and manufacturing control processes are critical to maintaining quality and reliability.” Currently, the Tube Assembly dimensional requirements allow for variation in the quantity of Cartridge Paper layers and subsequently affects the bursting strength, causing variability in pressure output. The thickness of the Sulfate Paper is a critical dimension as functional data appears to show a thicker paper and fewer layers causes increased variability in the bursting strength. Adhering to the historical TDP dimensional requirements is considered a significant factor in aligning with historical pressure characteristics and maintaining range precision requirements.

The purpose of this SBIR topic is to prototype an engineering change to the M299 IC system to optimize the form, fit, and function of the Tube Assembly, minimize variability in the bursting strength, and align with historical range precision performance.

The solution does not need to be made from paper. Alternative materials may be considered.
Current Paper Requirements:

1. Paper Properties:
    a. Standard Commercial Grade Paraffined Cartridge Paper
    b. Color: Yellow No. 33538 of FED-STD-595
    c. Basis Weight (gsm): 104 – 117 (Grams per Square Meter)
    d. Grade: P03-05
    e. Thickness (inch): .0047 to .0053; thickness of one spiral wrap of material
    f. Tensile Strength: 75 lbs minimum along the grain; 20 lbs minimum across grain
    g. Stretchability: 2.0% minimum along grain; 9.0% minimum across grain
    h. Weight: 70 lbs per 500 24” x 36” sheets
    i. Bursting Strength (psi): 70+

2. Bursting Strength:
MIL-DTL-32247 paragraph 4.58 defines the Bursting Strength Verification as the following:
    a. “The tube shall be cut in half lengthwise and one of the halves placed in the fixture. The stop shall be completely removed or backed off so that it does not touch the punch. Place fixture in universal tester set for a travel speed of 0.125 inches per minute. Proceed with Test Number 1 and 2.”
    i. TEST NUMBER 1: NO BURST
        1. Apply 57-pound compression load, remove tube. Item is rejected if evidence of bursting is observed. Tearing or puncturing of material shall be considered evidence of bursting.
    ii. TEST NUMBER 2: BURSTING
        1. If item is not rejected, replace it in fixture, using opposite end of tube and apply 192 pounds compression load. If item shows no evidence of bursting (punch travels through material), it shall be rejected.

3. Costs
The Flash Tube Assembly, of which the tube is a component, is estimated to cost $18. The redesigned tube should not increase the cost by more than 10%.

PHASE I: Develop concepts for the paper tube technology that meet the requirements described above. Demonstrate the feasibility of the concepts in meeting Marine Corps requirements by material testing and analytical modeling, as appropriate. Establish that the concepts can be developed into a useful product for the Marine Corps. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Develop a prototype Tube to be assembled to the Tube Assembly for evaluation to determine its capability in meeting the performance goals defined in the Description. Demonstrate technology performance through prototype evaluation and modeling over the required range of parameters. Use evaluation results to refine the prototype into an initial design that will meet Marine Corps requirements; and for evaluation to determine its effectiveness in an operationally relevant environment approved by the Government. Provide thirty (30) complete Tube assemblies that will be used in a live fire mortar testing event. Prepare a TDP for submittal to the Joint Safety Review Board. Provide test support during the live fire testing. Prepare a Phase III development plan to transition the technology into Marine Corps use.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use.

REFERENCES:
1. Department of Defense. “MIL-DTL-32247, CARTRIDGE, IGNITION, M299 FOR M821A1 HE CARTRIDGE FOR 81 MM MORTAR.” 18 December 2023. https://www.thinkpdfs.com/standards/MIL-MIL-DTL-32247/
2. Sun, V. et al. “120mm Mortar Ignition Cartridge Design Improvement and Black Powder Replacement [Presentation].” National Defense Industrial Association Conference, 41st Annual Armament Systems: Gun and Missile Systems Conference & Exhibition 2006, March 30. https://ndia.dtic.mil/wp-content/uploads/2006/garm/thursday/sun.pdf
3. Department of Defense. “MIL-A-2550B, GENERAL SPECIFICATION FOR AMMUNITION.” 8 February 1973. http://everyspec.com/MIL-SPECS/MIL-SPECS-MIL-A/MIL-A-2550B_8534/
4. Department of Defense. “MIL-STD-810H CHANGE 1, ENVIRONMENTAL ENGINEERING CONSIDERATIONS AND LABORATORY TESTS.” 18 May 2022. https://cvgstrategy.com/wp-content/uploads/2023/04/MIL-STD-810H-change-1.pdf

KEYWORDS: Ignition; Cartridge; Paper; Tube; Burst; Mortar

N252-075 TITLE: Outboard Engine Replacement

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment;Sustainment

OBJECTIVE: Modify a commercial four-stroke outboard engine capable of powering the Marine Corps Enhanced - Combat Rubber Raiding Craft (E-CRRC) and re-starting after immersion.

DESCRIPTION: This SBIR effort is to replace the Marine Corps Non-gasoline Burning Outboard Engine (NBOE) with a modified four-stroke commercial off the shelf (COTS) engine to power the E-CRRC. The modified COTS outboard must meet performance requirements for speed and payload when integrated with the E-CRRC, be capable of starting after immersion, integrate carrying handle(s), be capable of horizontal transport and storage, and meet noise and weight limitations. The immersion requirement is the most difficult and unique requirement to meet and is currently met using two-stroke outboard engines. Two-stroke outboard engines are no longer produced in the United States, presenting challenges with importing and authorization for use by the Environmental Protection Agency (EPA), as well as parts availability. Modification of a commercial four-stroke outboard will significantly increase reliability, fuel efficiency, and parts availability while still meeting the unique requirements of the Marine Corps.

The outboard engine must meet the following performance and integration requirements for use with the E-CRRC:
1. Four-stroke commercial outboard.
2. Propel the E-CRRC to 18 kts while transporting 2400 lbs, excluding boat, motor, fuel, and all Stock List-3 (SL-3) equipment, such as the outboard engine maintenance and on-board diagnostic kit.
3. Immersion and rollover protection.
    - Capable of immersion to depths of 3’ while inverted for 30 minutes.
    - Start within six minutes after immersion.
4. Capable of horizontal transport/storage.
5. Integrated carrying handle(s).
6. Non-reflective black exterior.
7. Not to exceed double hearing protection at the operator’s station per MIL-STD-1474E.
8. Weight not to exceed 270 lbs.
9. Starting method: Electric start, primary; Manual start, secondary
10. 20” shaft length.
11. Midsection transom clamps.

PHASE I: Define and develop a concept for a modified four-stroke outboard engine capable of meeting the Marine Corps requirements. Technical approaches may include purchase of multiple four-stroke outboard makes and models to determine technical feasibility of modifications required to achieve the results. Deficiency areas where four-strokes are unable to meet the requirements will be identified and concepts to overcome the deficiencies presented. Multiple approaches may be assessed in Phase I, but a prototype hardware solution (or multiple solutions) must be achievable within the time and funding scope of Phase II. Phase I proposals shall include but are not limited to: discussion of the performer’s experience and knowledge of relevant technologies and their application to marine outboard engines; the performer’s capability to develop and rapidly prototype hardware required to modify a four-stroke outboard engine; ability to estimate the cost and weight of the final concept; the performer’s ability to transition from concept and prototype to manufacturing. Supplementary material should include recent examples of the performer’s ability to develop, refine, and qualify relevant systems for use in military and marine operational environments and produce systems in significant quantities, utilizing either internal resources or via teaming or licensing agreements. Phase I proposals may include preliminary concepts which demonstrate understanding of the relevant trade spaces.

PHASE II: Develop and deliver at least one prototype four-stroke outboard engine suitable for demonstrating the required speed and payload performance, immersion capability, carry handles, and horizontal transport/storage. The prototype system is not expected to be optimized for physical and integration requirements, i.e., color and E-CRRC integration/attachment at this time, however, concepts to achieve all physical and integration requirements shall be presented. An estimate for the final carry weight should be provided with high confidence that the final weight requirement is achievable. Provide a plan for both low and full rate production, describing proposed fabrication capabilities and teaming or licensing agreements, if applicable. Provide a cost estimate for non-recurring initial resources and facilities as well as production of the final outboard engine solution.

PHASE III DUAL USE APPLICATIONS: Transition the prototypes to manufacturing and production of the final system suitable for use on the Marine Corps E-CRRC. Field the final system to Marine Corps units utilizing the E-CRRC.

There is potential for other military service interest in the engine or scaling of the technology and modifications development for larger or smaller outboards on multiple platforms.

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1. Outboard – Outboard motor – Wikipedia https://en.wikipedia.org/wiki/Outboard_motor
2. Combat Rubbing Raiding Craft – Combat rubber raiding craft – Wikipedia https://en.wikipedia.org/wiki/Combat_rubber_raiding_craft
3. Marine Corps Systems Command, Program Manager Infantry Combat Equipment, COMBAT RUBBER RECONNAISSANCE CRAFT
4. Product Information Sheet. https://www.marcorsyscom.marines.mil/Portals/105/PfM/GCES/PM_ICE/Info%20Sheets/Amphibious%20Reconnaissance%20Team/CRRC_PIS_2018.pdf?ver=2018-05-16-110754-940
5. Marines.mil. 31st MEU BLT 2/4 Small Boat Sustainment, Video posted 13 Dec 2024 https://www.cdi.marines.mil/MOC/Draft-Main-Page/videoid/946975/

KEYWORDS: Four-Stroke; Outboard; Engine; Boat; Speed; Payload

N252-076 TITLE: Augmented Reality Vehicle Maintenance & Training System

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Human-Machine Interfaces;Sustainment

OBJECTIVE: Develop an Augmented Reality (AR) capability that aids a maintainer with replacing the brake pads, brake disk, fuel filter, and water separator on a Ultra Light Tactical Vehicle (ULTV). The AR capability shall provide a reach back function in which the video feed of the maintainer's perspective can be wirelessly live streamed from one Electronics Maintenance Support System (EMSS) to another EMSS. The EMSS shall be the host system for the AR capability. The Prototype Device shall be designed with a platform agnostic architecture, in which the capability can be expanded to maintenance actions on multiple Marine Corps platforms.

DESCRIPTION: The problem at hand that the prototype device is intended to solve is a lack of ground vehicle maintenance training and overall maintenance experience. Vehicle maintainers in the Marine Corps have a wide range of varying experience, with some younger Marines having little to no experience with vehicle maintenance. To improve upon this knowledge gap, the Marine Corps is exploring AR to act as a real-time visual aid while conducting vehicle maintenance. The AR capability prototype device is intended to automatically detect vehicle components that are integral to the maintenance task at hand. The corresponding authoritative technical manuals and relevant schematics will be presented to the maintainer automatically upon component detection.

Another important objective of the AR capability prototype device is to provide a reach back capability in which an inexperienced Marine can contact a Subject Matter Expert (SME) in real-time. The end goal is to be able to have the SME be in an entirely different location than the maintainer, be able to see the live visual feed of the maintainer and provide resolution to the issue at-hand. This capability will directly support the Marine Corps approach of Expeditionary Advanced Base Operations (EABO).

The following is a detailed list of the scope of this SBIR effort:

- Develop an AR capability that:
  - can visually aid the user with replacing the brake pads, brake disk, fuel filter, and water separator on a ULTV, using ULTV schematics and technical manuals as the authoritative source.
  - can replace all four ULTV components: brake pads, brake disk, fuel filter, and water separator (Threshold (T)); replace all four ULTV components listed in the threshold, as well as any additional maintenance actions beyond those four (Objective (O)).
  - integrate with the EMSS hardware and software configuration.
  - is capable of providing a live video feed from the AR device to a different EMSS via wireless transmission.
- Augmented Reality Visual Aid Size:
  - Nominal hindrance to maintenance tasks while wearing a noticeable but not uncomfortable device (T); minimum hindrance to maintenance tasks while wearing a device with a small footprint and does not obscure the maintainer from the task at hand (O).
- Augmented Reality Visual Aid Device:
  - Wired operation between the device and EMSS (T); wireless operation between the Prototype Device and EMSS (O).
- Battery Life:
  - One-hour battery life while in operation (T); two-hour battery life while in operation (O).
- System Weight:

  - Two person portable with all accessories (62 lbs.) in accordance with MIL-STD-1472H (T); one person portable with all accessories (31 lbs.) in accordance with MIL-STD-1472H (O).
- Ruggedized:
  - Not ruggedized (T); ruggedized in accordance with MIL-STD-810H (O).

Note: The replacement cost should be considered during prototype device development. If the prototype device is not ruggedized, it is more likely to break and be in need of replacement.

PHASE I: Identify a technically capable solution for providing an AR capability within the hardware and software constraints of the EMSS. The required Phase I deliverables shall be a report which outlines the hardware and software approach of the AR capability. The report is expected to include the following:

- Analysis of AR hardware solutions, with a definition of pros, cons, tradeoffs, and a recommended prototype hardware solution
- Analysis of AR software solutions, with a focus on ease of development, software supportability, integration into EMSS, cyber compliance considerations, and future integration/expandability of the capability.
- Analysis of existing ULTV models and schematics, with a determination on if the existing Technical Data Package is sufficient to produce a prototype solution. If the models provided are insufficient, the proposal shall include a concept for creating the models utilizing 3D scanning methods. A ULTV will be made available to the prototype developer to accomplish this effort.

PHASE II: Produce and validate an AR capability that can assist a maintainer with changing out the brake pads, brake disk, fuel filter, and water separator on a ULTV; and provides a wireless video feed reach back capability (O). The prototype device shall be capable of identifying components that are integral to performing the steps needed to change the ULTV brake pads, brake disk, fuel filter, and water separator. Once a component is identified, the prototype device shall visually display the corresponding Technical Manual and schematic information to the user.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the final product into its EMSS.

The commercial automative industry has started to integrate AR maintenance aids into their processes and practices. The government prototype device solution will be open source, which means that commercial automative industry companies that have not adopted this capability could utilize the prototype device solution.

This solution also could be utilized in the civilian environment for personal maintenance actions. The older generation is more knowledgeable on conducting car maintenance than the younger generation. This solution could be sold as a training aid to schools or vehicle hobbyists that need a way to teach and learn vehicle maintenance.

Additionally, this capability could have uses in different commercial sectors, such as electronics, home repair, plumbing, etc.

REFERENCES:

1. Department of Defense. “MIL-STD-810H CHANGE 1, ENVIRONMENTAL ENGINEERING CONSIDERATIONS AND LABORATORY TESTS.” 18 May 2022. https://cvgstrategy.com/wp-content/uploads/2023/04/MIL-STD-810H-change-1.pdf

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3. Getac. "EMSS Laptop Hardware/Software Specification B360." https://www.getac.com/us/products/laptops/b360-pro/#tech-specs

KEYWORDS: Augmented; Reality; Training; Aid; Maintenance; Decision; Artificial Intelligence

N252-077 TITLE: Tactical Sled Loader (TSL) Material Handling System and Cargo Sled

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment

OBJECTIVE: Develop a Tactical Sled Loader (TSL) to provide the Marine Corps with the capability to rapidly load/offload munitions and cargo with an emphasis on speed to avoid enemy detection and targeting cycles plus the capability to transfer equipment and supplies with a variety of dimensions and weights to and from aircraft and ground transportation assets.

DESCRIPTION: The need for a newly developed TSL originated from a Deliberate Universal Needs Statement (DUNS) from INDOPACOM. The DUNS was vetted through the capabilities portfolio integration board and received a decision memo to pursue and develop solutions. The TSL consists of a Sled Loader hereafter referred to as the Loader and a Cargo Sled hereafter referred to as the Cargo Sled. The Cargo Sleds shall vary in size (primarily their width) to accommodate the various aircraft Cargo cabin dimensions (MV-22 Osprey, CH-53K, C-130). The Loader shall be one size and able to be transported in an MV-22 Osprey (the smallest transport aircraft).

The TSL system shall be equipped with a Loader designed to facilitate the efficient loading and unloading of cargo-laden Sleds to and from assault support aircraft, including but not limited to the MV-22, CH-53K, and C-130.

Tactical Sled Loader (TSL) Requirements

1. Shall employ a combination of manually operated winches and friction-reducing devices (such as rollers) to enable operators to smoothly transfer the loaded Cargo Sled between the Loader and the aircraft’s Cargo drop down hatch.
2. Shall have an adjustable height between 25” and 45”, ensuring compatibility with various assault support aircraft mentioned above by accommodating differences in Cargo hatch height and facilitating the loading and unloading of the aircraft (MV-22 lowest point and C-130 highest point) and allowing for independent modification of the Loader's pitch and roll. (Note: The platform of the Loader must remain integrated and move uniformly during adjustments. Any height adjustments must be performed manually, requiring continuous user input, and must not damage the Cargo. All hydraulic systems used for this purpose shall employ braided steel lines.)
3. Shall be designed for easy towing and repositioning, both when loaded and unloaded, utilizing standard tow vehicles or by hand.
4. Shall be equipped with tie-down points and parking brakes to ensure stability and safety during loading and unloading operations. (Note: These parking brakes must be sufficiently robust to securely hold a fully loaded TSL, preventing any risk of tipping or slipping when stationed on a flight deck or in a hangar. Some sort of visual indicators that can warn an operator that the load is reaching an unsafe position (e.g., dial indicator) should be considered.
5. Shall contain an integrated, adjustable guide system incorporated into the Loader design to prevent the Cargo Sled from deviating off course during loading and unloading procedures, ensuring a secure and controlled operation; to enable the Loader to expand by a minimum of 8 inches on each side to accommodate Cargo Sleds designed for use in larger aircraft such as C-130 and CH-53K; that is easily retractable to accommodate smaller Cargo Sleds used on MV-22 osprey aircraft; to prevent any lateral movement of the Cargo Sled, ensuring it remains securely on the Loader during operations; to avoid any damage upon contact between the Cargo Sled and the Loader; and to adjust to accommodate Cargo Sleds ranging from 63 to 85 inches in width.
6. Shall feature a versatile four-wheel steering configuration, designed for both towing behind military vehicles and manual pushing or pulling.

7. Shall interface seamlessly and provide adequate support to the small Cargo Sleds developed specifically for MV-22, and large Cargo Sleds designed specifically for C-130, and CH-53K aircraft, collectively referred to as the aircraft, during both loading and unloading operations.
8. Shall be constructed robustly to able to withstand the stresses, shocks, vibrations, and other conditions associated with towed movement and rail, truck, and air transport.
9. Must be compatible for towing with a variety of small vehicles typically found at air terminals, in addition to military vehicles. [Ref 4].
10. Must enable controlled transfers of loaded Cargo Sleds to and from the aircraft Cargo area with all equipment necessary for these transfers, such as winches, rollers, and guide rails, permanently integrated into the Loader. (Note: Leveraging the aircraft's winch system for transferring Cargo Sleds from the Loader to the aircraft is permissible.)
11. Shall incorporate a manually operated winch system, potentially comprised of multiple winches, that must facilitate the movement of the Cargo Sled from the aircraft's Cargo area to the Loader; and should provide pulling capabilities at the front-center, front-right, and front-left of the Cargo Sled. (Note: Simultaneous pulling from the front-right and front-left shall be equivalent to a central pulling load. The intent is to reduce the personnel required to operate this system for cargo movements over legacy methods.)
12. Must not exceed dimensions of 140 inches in length, 65 inches in width, and 25 inches in height in its storage configuration; the height shall be adjustable from 25" to 40" and the width shall be expandable from 65" to 85".
13. Shall not exceed 3,500 lbs in weight, inclusive of all operating fluids and hydraulic reservoir at operational levels.
14. Must be capable of handling loads up to 10,000 pounds (i.e., the "rated load").
15. Must maintain stability when lifted via forklift in an unloaded state, and should allow lifting from both sides, adhering to section 3.3.4.2 of MIL-S-8512D. (Note: Reinforced forklift tine guides, preferably pockets, must be provided for safe and positive insertion, ensuring no damage occurs during lifting. The center of gravity of the Loader, when unloaded, shall be clearly marked on the Loader itself.)
16. Lift/Tie down points conforming to MIL-STD-209K, Interface Standard for Lifting and Tie-down Provisions for all forms of transportation, which serve multiple purposes: lifting the Loader, tying down the Loader, and securing the Cargo Sled to the Loader. (Note: The Loader must not be lifted in a loaded state but should be secured adequately when loaded.)
17. Must be capable of operating in temperatures ranging from -25° to +125°F, capable of operating in 6" Threshold, 24" Objective and near salt water, and compatible with amphibious and commercial shipping.
18. Must be capable of operating in day and night conditions and be capable of providing adequate operator-adjustable lighting for night operations.
19. Must have axle weights (front and rear) that meet the weight restrictions of a C-130, CH-53K, and MV-22 military aircraft.
20. Must be equipped with service brakes capable of stopping and holding the TSL with rated load either forward or backward on a 30-degree slope; and a parking brake that must restrain the TSL with rated load on at least a 30-degree slope.
21. Must be capable, with rated load, of negotiating both an angle of approach and an angle of departure of at least 20 degrees for negotiating the ramp of a landing craft and shall be able to negotiate a longitudinal slope of at least 45 percent in both forward and reverse at a speed of not less than 2 mph; and of negotiating at a 15 percent cross slope in full circle operation in both directions at maximum steer angle without any tire leaving the ground.
22. Must be capable, with rated load, of traversing uneven and unprepared surfaces (rough terrain) to include sand, snow, and mud.
23. Must be capable, with rated load, of traveling forward on flat firm ground at speeds of at least 8 mph and of executing a 360-degree turn.

24. Must be equipped with pneumatic tires that meet the load requirements of the TSL.
25. Must be corrosion resistant (i.e., must meet or exceed current ground equipment protection standards) during unprotected storage and from the effects of a salt-water environment.
26. Must be equipped with a 24-volt negative-ground electrical system or at a minimum have a 12/24 dual system with 24-volt alternator, 24 starter and battery equalizer. (Note: A NATO standard electrical slave receptacle shall be provided.)
27. Must contain commercial standard diagnostic capabilities. (Note: Design shall be such that maintenance and repair can be conducted with common tools wherever possible. No unusual mechanical skill should be required at any echelon of maintenance.)
28. Must be equipped with a rear axle that can oscillate above and below the horizontal axle centerline.
29. Must be equipped with integral tie-down brackets, a rear towing pintle and appropriate lifting eyes. (Note: The towing pintle hook shall be accessible for removal or adjustment.)
30. Must meet applicable DoD human engineering, health, and safety standards and employ user-friendly features for personnel operating in or near the TSL throughout its life cycle. (Note: The TSL design and engineering must be able to achieve certification to handle conventional ordnance and transportability onboard MV-22, CH-53K, and C-130 aircraft.)
31. Must be capable of being embarked and disembarked, without disassembly, aboard all roll-on/roll-off (RO/RO) ships and amphibious shipping/craft.

For Chemical, Biological, Radiological, and Nuclear, Biological, (CBRN) Survivability, only Chemical, Biological, and Radiological contamination survivability is required. Nuclear survivability is not required. Two types of Cargo Sleds will be developed to accommodate the dimensions of the supported aircraft: a small Cargo Sled designed for use with MV-22 and a large Cargo Sled developed for use with CH-53k and C-130 aircraft.

Cargo Sled Requirements

1. Shall have side, forward, and aft fork pockets to enable lifting from all sides.
2. Shall have a weight capacity of 10,000 lbs. (i.e., “rated load”).
3. Must interface with the aircraft Cargo deck rollers and floor locking systems of aircraft.
4. Must have adequate tie down points to accommodate a range of loads.
5. Will have weapons interface adapter positions for the install of bomb saddles and or missile cradles to support the All Up Round Transport of Weapons as with the MHU-110 munitions trailers.

PHASE I: Develop concepts for a TSL and Cargo Sleds that meet the requirements described above. Demonstrate the feasibility of the concepts in meeting Marine Corps requirements. Establish that the concepts can be developed into a useful product for the Marine Corps. Feasibility will be established by material testing and analytical modeling, as appropriate. Provide a Phase II development plan with performance goals and key technical milestones, and that will address technical risk reduction.

PHASE II: Deliver two working TSL prototypes and three Cargo Sleds for evaluation to determine their capability in meeting performance goals defined in the Description above. Demonstrate technology performance through prototype evaluation and modeling over the required range of parameters. Evaluation results will be used to refine the prototype into an initial design that will meet Marine Corps requirements; and for evaluation to determine its effectiveness in an operationally relevant environment approved by Government. Prepare a Phase III development plan to transition the technology to Marine Corps use. The technology should reach Technology Readiness Level (TRL) 6/7 at the conclusion of this phase.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Support the Marine Corps for test and validation to certify and qualify the system for Marine Corps use. The prototypes shall be TRL 8 at the conclusion of testing.
Commercial applications may include, but not be limited to, airline industry, logistics, and warehouse/manufacturing operations.

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KEYWORDS: Material Handling; Munitions; Sustainment; Contested Logistics; Aircraft; Cargo; Transportability; Equipment; Distribution; Multi-Domain

N252-078 TITLE: Night Passive Aiming System

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber;Microelectronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a low-cost Night Passive Aiming System (NPAS) for individual small arms.

DESCRIPTION: This SBIR effort is to develop a low-cost NPAS for individual small arms engagement at night. Marines currently utilize night vision goggles (NVGs) with weapon mounted, near-infrared (NIR), laser pointer/illuminator systems [Ref 1] to place projectile aimpoints on targets and extend target detection distances when ambient illumination is insufficient for image intensifier (I2) sensor operation. Emissions from laser devices are easily detectable by hostile forces equipped with similar night vision capabilities or modern low-light silicon imaging sensors, as found in cell phones or webcams. The nature of small arms projectile ballistic flight also constrains laser pointer engagement distances as the operator must eventually raise the aimpoint above the target’s head to compensate for bullet drop. Currently fielded night vision weapon sights, both I2 and thermal imaging, provide corrected aimpoint reticles for long range engagements, but are not at a price point amenable for issuance to every infantry Marine. Their relatively narrow field of view also inhibits the user’s ability to rapidly acquire and engage close range targets when compared to NVG/laser engagements.

Technical approaches should emphasize both low cost and light weight (no greater than contemporary small arms laser pointer devices). Multiple approaches may be assessed in Phase I, but a prototype hardware solution (or multiple solutions) must be achievable within the time and funding scope of the base Phase II effort. In all phases of the effort, the proposer shall provide target and environmental modeling assumptions and sensor/optical parameters where applicable.

The prototype system is not expected to be optimized for power consumption, nor to meet full military operational environment requirements; however, it shall be suitably robust for use outdoors in temperate climates. The prototype system should be capable of live fire demonstration on the M27 IAR. Batteries, if applicable, shall be removable by the operator. The prototype should include an external power capability to operate on 120VAC power via an adapter and without internal batteries installed, if applicable.
For NVIPM modeling, the recommended relevant parameters are: 0.75 meter target characteristic dimension, V50 (detection) = 1.5 cycles, V50 (recognition) = 2.2 cycles, 2 Kelvin target contrast for thermal band imaging, and 25% target contrast for reflectance band imaging.

The solution concept of operation shall have sufficient field of view to observe projectile impacts on target, rapidly search for and detect targets, and maintain situational awareness of friendly forces approaching perpendicularly to the target area before they enter the cone of fire. Preferred solutions should not preclude the use of the SBNVG for continuous local situational awareness and dismounted movement at night.

The performer shall provide a plan for both low and full rate production, describing proposed fabrication capabilities and teaming or licensing agreements, if applicable. The performer shall provide a cost estimate for non-recurring initial resources and facilities as well as production of sight systems based on step ladder pricing.

NPAS solutions:

1. shall be operable with the M27 Infantry Automatic Rifle (IAR), equipped with the M83 Squad Common Optic (SCO) and a muzzle-mounted suppressor (Threshold).
2. shall not preclude the use of NIR laser pointer/illuminator devices on the rifle forward handguard rails (note: positioning of laser pointer devices is flexible to accommodate operator preference).
3. shall assume all operators will also be equipped with the AN/PVS-31D Squad Binocular Night Vision Goggle (SBNVG), which has the ability to rotate monoculars individually away from viewing position if needed.
4. should accommodate, but not be dependent upon, a limited number of operators being equipped with clip-on night sights along the topside handguard rail (ex., AN/PAS-35 Squad Thermal System/Family of Weapon Sights-Individual) and/or supplemental thermal imaging capability for the SBNVG via the AN/PAS-29B Enhanced Clip-On Thermal Imager (E-COTI) (Objective).
5. may utilize or interact with components already issued to all operators, such as the SBNVG. If the solution includes a dedicated night imaging sensor or optically interacts with other sensors, it is recommended that proposers utilize the U.S. Army Night Vision Integrated Performance Model (NVIPM) for sensor range predictions. A copy of NVIPM software can be provided as Government Furnished Information upon contract award, however proposers are expected to have prior proficiency in use as training will not be provided by the Government.
6. shall provide the operator a 70% probability of detecting and engaging personnel targets [Ref 2] at no less than 300 meters in clear air starlight conditions (~1 millilux), without the use of active illumination sources.
7. should provide target recognition and engagement capability at no less than 500 meters in overcast starlight conditions (~100 microlux).
8. should be capable of performing the stated task in dirty battlefield and adverse weather conditions at no less than one-third the clear air range. (Note: Recognition shall be evaluated by the ability of the operator to detect and correctly count the number of upright personnel within a group with no more than 50% line of sight positional overlap between individuals presenting a frontal aspect.)

Phase I proposals shall include, but are not limited to, discussion of the performer’s experience and knowledge of relevant technologies and their application to optical systems for small arms; the proposer’s ability to model the size, weight, power, cost, and range performance of optical systems for small arms applications; and the proposer’s capabilities for rapid prototyping and relevant prior examples. Supplementary material should include recent examples of the performer’s ability to develop, refine, and qualify relevant systems for use in military operational environments and produce systems in significant quantities, utilizing either internal resources or via teaming or licensing agreements. Phase I proposals may include preliminary concepts that demonstrate understanding of the relevant trade spaces.

PHASE I: Define and develop a concept for a NPAS. Establish the feasibility of the concept. Prepare a Phase II plan.

PHASE II: Develop and deliver at least one hardware system prototype suitable for demonstrating the range performance, operator employment, and approximate size and weight of the preferred concept on relevant small arms systems. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Further refine the sight system for optimization of size, weight, power, and manufacturing cost and for survivability in the conditions associated with weapon firing shock and the military operational environment. Deliver sufficient representative sight systems to allow qualification and Marine user evaluation for refinement prior to full rate production.

Dual use applications include law enforcement and civilian self-defense or hunting, subject to ITAR and local government restrictions. Related applications may include augmented reality and machine vision systems.

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KEYWORDS: Sensors; Optics; Fire Control; Sights; Small Arms; Weapons; Targeting

N252-079 TITLE: Binary-Level Automated Vulnerability Detection and Patching without Source Code

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop innovative approaches to automatically find and fix software vulnerabilities in binaries without source code. The capability should be robust enough not only to identify zero day exploits and vulnerabilities, which can be weaponized for offensive purposes but, also implants (for defense against supply chain attacks) and malware.

DESCRIPTION: Due to the prevalence of programmers copying and pasting code into their projects, or the inclusion of libraries of unknown origin or quality, the security of the software that underpins critical systems is always in question. Because of this, methods to quickly secure new and existing critical software used in the Fleet is needed for all Program Management Activities and Program Executive Offices. Current techniques to secure software involve manual vulnerability discovery and remediation using subject matter experts (SME) and typically requires access to the source code. However, the source code is usually not available for analysis especially for legacy applications, weapon systems, control systems, and communication systems whose software is proprietary. For this SBIR project, the small business awardee will develop novel approaches to automatically perform security assessments on compiled binaries of multiple instruction set architectures to detect known and unknown vulnerabilities (greater than 90% success rate) and automatically develop patches for any found vulnerabilities.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Determine the technical feasibility of binary level automated vulnerability detection and patching without source code including:
1. Determination of the major challenges and preliminary feasibility of software algorithms.
2. Development of an initial concept design that supports binary level automated vulnerability detection and patching without source code.
The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and demonstrate a prototype for binary-level automated vulnerability detection and patching without source code. The prototype deliverables should include:
1. Design and development the algorithms required to perform binary-level automated vulnerability detection and patching without source code.
2. Demonstrate the ability of the prototype to harden vulnerable binary software.
3. A technical roadmap that takes the program through Phase III must be part of the final delivery for Phase II.

Work in Phase II may become classified. Please see note in Description paragraph.

PHASE III DUAL USE APPLICATIONS: Complete final testing, perform necessary integration and transition for use in monitoring operations/applications with appropriate platforms and agencies, and future combat systems under development.
Commercially, this product could be used to enable security monitoring.

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KEYWORDS: Source code; binary; vulnerability; Artificial Intelligence; Machine Learning; AI/ML; software; cybersecurity

N252-080 TITLE: Multi-Spectral Quantum Dot Array

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber;Quantum Science

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design a multi-spectral Quantum Dot (QD) array with a Read-in Integrated Circuit (RIIC) to provide the capability for system design and integration of a high-fidelity Screen Projector (SP) to support testing and evaluation (T&E) of a multi-spectral sensor and seeker. Each array pixel will be populated with between two to four multi-spectral quantum dot emitters and can demonstrate narrow band spectral output in either the ultra-violet (UV), visible, Near Infrared (NIR), Mid-Wave IR (MWIR) band 4a and b, or Long-wave IR (LWIR).

DESCRIPTION: This SBIR topic will investigate multispectral narrow-band QD arrays with emission wavelengths centered for chemical and remote sensing, as well as seeker and sensor modeling and simulation. Multispectral emission from UV to LWIR is potentially useful for chemical spectral analysis, remote sensing, and SP threat engagement simulation as part of a scene projection system. A multispectral band QD array with a narrow-band QD emitter providing electromagnetic radiation in multiple spectral bands is highly beneficial for DoD applications. The narrow-band emission of QDs will enable more precise spectral emissions for chemical composition analysis; provide the core technology for smaller, lighter, and more versatile projection systems; and provide the capability for better wavelength selection for remote sensing applications.

The Navy desires a multispectral 1024 X 1024 emitting array with multiple QDs designed onto each array pixel. Each QD will have a narrow band emission of less than 100 nanometers for better wavelength precision of application-specific operations on chemical and remote sensing. The individual QDs integrated onto each pixel will demonstrate apparent temperatures above 1500K for improved brightness levels needed for SP and remote sensing applications. Multispectral QD arrays will improve the T & E capability of modern and future seeker and sensor projection systems for more effective Hardware-in-the-loop (HITL) and live-virtual-constructive (LVC) testing of multispectral threat detection and warning systems. The RIIC and QD emitter array must provide up to 5 orders of magnitude dynamic range with at least 16-bit resolution. The crosstalk between QD wavelength-specific emitters of less than 1% is needed between all wavelengths but is particularly important for the MWIR bands 4a and 4b. These attributes improve spatial and spectral resolution for chemical and remote detection and modeling projection systems for improved warfighter battlefield survivability.

The proposed approaches will include designing, fabricating, and characterizing the multispectral QD arrays to match Navy-defined in-band emitter wavelength and ranges. An electronically multiplexed QD array suitable for high-fidelity hardware-in-the-loop will have a Phase I LED array approach designed and a Phase II demonstration. It will allow the test programs to tailor flight test scenarios based on HITL test results, reduce flight hour requirements, and improve overall test efficiency. For chemical and remote sensing, this capability will support the warfighter's need to analyze and detect biological or chemical agents. The Navy needs enhanced multispectral scene projectors that are smaller and lighter for placement on HITL and flight line T & E.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop a concept for a multi-spectral QD array structure. Write a final report on the design and feasibility of a multi-spectral QD array structure, including the RIIC concept. The Phase I effort will include prototype plans to be developed in Phase II.

PHASE II: Develop a 1024 X 1024 multi-spectral array structure with independently controlled pixels by a RIIC. Demonstrate the multi-spectral narrow spectral band (
Work in Phase II may become classified. Please see note in Description paragraph.

PHASE III DUAL USE APPLICATIONS: Integrate a 1024 X 1024 multispectral QD array with a RIIC and develop a multi-spectral scene projector. Support transition of the Infrared Scene Projector (IRSP) developed in Phase III to Navy T&E laboratories.
A multi-spectral emitting array has potential application for industrial chemical sensing and safety protection. A multi-spectral scene projector has application for both firefighter and medical scenario training.

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KEYWORDS: Quantum; Read-in Integrated Circuit; RIIC; Near Infrared; NIR; Mid-wave Infrared; MWIR; Long-range Infrared: LWIR; multi-spectral scene projector; Electro-Optical and Infrared; EO/IR

N252-081 TITLE: Intelligent Radio Access Network for Beyond 5G Resilient Tactical Networks

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;FutureG;Integrated Network Systems-of-Systems

OBJECTIVE: Research and develop cost-effective communication systems for use in Anti-Access and Area Denial (A2AD) environments via platform-assisted Intelligent Radio Access Network operating as a Beyond 5G (B5G) base station or relay in Resilient Tactical Networks.

DESCRIPTION: Tactical operations are often set in remote locations where cellular infrastructure such as 5G are absent. Military operations such as intelligence, surveillance, and reconnaissance (ISR) can benefit immensely from high speed, low latency 5G communication links. The high-capacity links can enhance command and control (C2) with the high data rate 5G links enabling situation awareness between deployed troops. Another aspect to consider in practical tactical scenarios is user mobility, i.e., the soldiers/tactical vehicles with handheld 5G radios user equipment (UE) are not stationary. Mobility of users result in varying link conditions causing coverage holes in the network. The aerial 5G base station positioning must consider the dynamic link conditions due to mobility and other propagation effects such as Weather Disruptions, Jamming, and Distance/Fading loss due to signal strength. A traditional lookup table-based approach is not adaptive to learn from the dynamic UE environment.

This SBIR topic seeks the development of an inexpensive platform B5G communication system that can operate in contested/congested environments with challenging and dynamic realistic B5G operating conditions in both stationary and on-the-move (OTM) conditions. The platform 5G base station will extend 5G Radio Access Network (RAN) coverage and enable high data rate beyond Line of Sight (LoS) communication among the UEs. To provide this capability, a new intelligent link adaptation subsystem to the B5G RAN architecture is required to improve link resiliency by choosing the appropriate Modulation and Coding Scheme (MCS) scheme for the UE-to-base station link. Thus, the dynamic platform 5G-base station enables large-scale network coverage, UE mobility support, enabling networking to on-the-move for highly dynamic tactical mission consequently providing next generation of assured robust connectivity. The intelligent link adaptation module in conjunction with the platform 5G base station for multi-cell connectivity is envisioned to provide a significant performance leap in terms of UE mobility management, Quality of Service (QoS) specific high data rate guarantee, and sustain reliable connectivity in support of dynamic, remote tactical missions. The proposed scheme must be scalable and can easily accommodate multiple platform 5G-base stations and platform 5G relayers for very large network scenarios. The proposed approach must be able to perform multi-cell connectivity via multiple Unmanned Air Vehicles (UAV) equipped with 5G base stations and UAV 5G relayers and includes the following capabilities:

- High-Level Decision Maker—adaptive 5G UE support for efficient network routing strategy that minimizes 5G network control overhead (“Network control overhead” refers to the amount of additional 5G information required to maintain network services)
- Director—multifunction optimization and conflict resolution to accommodate 5G UE communication tasks,
- 5G Mesh Network Optimization and Learning Engine—dynamic, context-based learning recognizing a 5G disruption event, classifies the 5G disruption event then based on the type of 5G disruption, suggests a mitigation strategy for strengthening the 5G network topology and improving 5G network performance
- Weight Adjuster—discerning critical factors contributing to an effective 5G UE mesh network solution
- Compliant interfaces—seamless 5G UE connection to internal platform communication subsystems and external 5G systems

- Multi-objective reasoning in dynamically changing A2AD environments to enable transfer large data sets in minimal time in synchronous and asynchronous modes among UEs, using either or all the following: data throttling, data compression, Data Error Detection & Correction
- Context-based access management to minimize 5G UEs communication detection, intercept and targeting
- Efficient 5G system switching and mesh capability resource allocations in an A2AD environment
- Reinforcement learning framework that overcomes uncertainty and avoids reliance on static 5G MATLAB data flow model,
- Scalable across multiple different 5G transceivers to operate in A2AD dynamic contested environments
- Robust to different cyber environments through context-based authentication
- Software to sustain 5G link connectivity and if lost reacquisition of connections in A2AD environments
- Vendor-agnostic 5G equipment integration with UAVs and their respective systems and subsystems
- Hybrid decentralized approach for local decisions to support multiplatform 5G UEs collaboration in A2AD environments
- Near real-time mission feedback with reduced 5G system processing times
- Lightweight 5G signaling in a hierarchical command and control (C2) structure supporting battlefield applications with multiple 5G UE distributed platforms
- Negating radio frequency (RF), cyber takeover of unmanned and manned air vehicles
- Compliance with IEEE 802.15.3-2023: Standard for Wireless Multimedia Networks (Threshold (T))
- Compliance with IEEE 802.11ac: Wi-Fi 5 Standard (T)
- Compliance with IEEE 802.11ad: Multiple Gigabit Wireless System (MGWS) (Objective (O))
- Compliance with IEEE 802.11ax: Wi-Fi 6 Standard (O)
- Compliance with FCC CFR 47 Part 15 and Annex K regulations (T)

Proposers may use the multi-path transmission control protocol (MPTCP) published by the Internet Engineering Task Force (IETF). The MPTCP is implemented in layer 4 (transport).
Proposers may use vehicle-to-vehicle (V2V) or vehicle-to-everything (V2X) communication protocols specified by the 3GPP standards for 5G cellular networks.

While 5G networks provide significant benefits and opportunities in terms of high bandwidth and connectivity, traditional security models have major weaknesses in protecting the 5G network infrastructure. The unique characteristics of 5G networks include: (a) seamless connectivity of heterogeneous devices, (b) high network mobility, and (c) distributed network assets enabling access to cost-effective resources for all devices. While 5G networks enable new applications, the use of untrusted network elements arises major security concerns for DoD operations. Traditional network security models assume a known network perimeter as the critical resources to be protected against unauthorized access. The distributed resources and assets of 5G networks make the identification of network perimeter challenging – even impractical. Further, the high mobility of 5G networks requires a dynamic security and risk assessment. To address this issue, zero trust (ZT) principles must be part of the proposed B5G communication system. ZT principles include the trust of a subject requesting access to critical resources continually and dynamically assessed during the entire period of the access. In a 5G network specifically, the mobility of heterogenous devices in a varying environment calls for a dynamic model of the network state that provides information about the risks of accessing a particular resource by a given subject from a particular location.

PHASE I: Perform a trade study between system size, architecture, operating frequency, operating bandwidth, efficiency enhancement schemes, modulation format, data rate, power consumption, anti-jamming capabilities, Low Probability of Intercept (LPI), and Low Probability of Detection (LPD), and zero trust (ZT). Develop a system level model of a Unmanned Aerial Vehicle (UAV) 5G base station transmitter/receiver based on optimized parameters selected from the trade study. Develop a small set of 6–8 independent intelligent yet cooperating UAV 5G systems, which will coordinate their activities to perform some limited-scope 5G communication scenarios and missions. Validate a system level model of a 6–8 UAV 5G base station transmitter/receiver based on optimized parameters in an Extendable Mobile Ad-hoc Network Emulator (EMANE). Required Phase I deliverables, in addition to the standard Contract Deliverables described in the BAA instruction, will include a report with a demonstration plan, UAV 5G system hardware and software designs, and performance goals. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Fabricate and demonstrate 6–8 5G prototype hardware and associated software kits to be integrated and operated on 6–8 UAVs as prototype systems. Make available these UAV 5G prototype systems for evaluation to determine their capability in meeting the performance goals defined in the Phase I report and to perform to the Government's criteria for holding operational evaluation and capability demonstrations. Construct and demonstrate the operation of a TRL 6/7 5G UAV 5G prototype system-assisted Intelligent Radio Access Network operating as a B5G base station or relay in a Resilient Tactical Networks operating in a relevant over-the-air outdoor maritime environment. Incorporate the ZT principles and techniques developed in Phase I into the UAV 5G prototype systems. Deliver these UAV 5G prototype systems to the Government with an associated user manual, interconnect diagram, and a report documenting the results of the Phase II effort. Provide any virtual and/or on-site support requested by the Government during 5G prototype UAV systems' operational evaluation and capability demonstrations.

PHASE III DUAL USE APPLICATIONS: Finalize software development of the manned-unmanned directional mesh networking system with compatibility to open architectures and address any unique requirements for Manned-Unmanned interoperability with a particular data link(s), perform a more formal systems integration task to provide effective software interfaces to particular naval assets, perform operational testing, and participate in integrated demonstrations of Manned-Unmanned networking systems operations.

Demonstrate a field-ready software system with mature implementation in an open relevant operational environment. Perform technology insertion and program integration using engineering model of proposed product/platform or software. Develop and provide a full report of development, capabilities and measurements (showing specific improvement metrics). Provide a user's guide and other documents as necessary for Navy to recreate and use the demonstration capability or software/hardware component(s). Identify and summarize opportunities and plans for potential commercialization.

Military Application: Increase the number and types of platforms able to connect into the UAV network. Improve the throughput, latency, and reliability of existing airborne networking technologies. 5G transceivers provide high data throughput, frequency agility, and covert operation in A2AD environments and will support a variety of military applications, including wireless networks of multiple manned or unmanned ground vehicles supporting ground V2V, vehicle-to-infrastructure, UAS-to-UAS, and UAS-to-ground vehicle/infrastructure communication links.

Commercial Application: Results from this work have applicability to cellular telephone and data networks, to vehicular networks, and to WiFi networking technologies. Civilian applications of 5G technology includes mmWave long-range links such as last mile, small cell networks, mobile backhaul, Internet of Things (IoT) wireless networks, and 5G networks that can benefit from the reduced interference and improved reliability for high-speed datalinks. In addition to commercial Unmanned Aircraft Systems (UASs) and ground vehicles mirroring the military applications, an emerging Vehicle-to-everything (V2X) market will benefit from the proposed transceiver capabilities, especially with the wide adoption of autonomous vehicles.

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KEYWORDS: Tactical Airborne Networks; Mesh Networks; Directional datalink; Backward Compatibility; Time Division Multiple Access; TDMA; Experimentation

N252-082 TITLE: Adaptive Bypass Valve for Solid Fuel Ramjet Missile

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment;Trusted AI and Autonomy

OBJECTIVE: Research and design a state-of-the-art airflow bypass valve between the inlet and the combustor in a solid fuel ramjet missile to control the amount of airflow by positioning at any degree of opening from off to on and on to off, thus allowing the control of thrust, resulting in potential range extension.

DESCRIPTION: Ramjets are ideally suited for supersonic flight within the atmosphere. Among the different ramjet configurations, the Solid Fuel Ramjet (SFRJ) is the simplest and safest design with the highest density-specific impulse. However, the uncontrollability of the combustion process in the SFRJ engine is still the main challenge in this technology. Complex issues include engine unstart, fuel regression complexity, and flame extinction.

This SBIR topic is soliciting innovative proposals for researching, designing, and prototyping a state-of-the-art airflow bypass valve between the inlet and the combustor in supersonic SFRJ missiles.
The electromechanical valve precisely controls the airflow in the combustion system by splitting the inlet airflow into the combustor stream and the annular bypass duct stream around the combustor. Bypassing air around the fuel grain is a promising technique to regulate thrust and improve combustion efficiency. The feasibility of this technique is supported by preliminary development of this adaptive valve. The high-speed precision actuator of this valve adjusts the size of the valve opening in response to a signal from a separate control system unit which is not part of this topic. An adaptive valve would control the amount of airflow by positioning at any degree of opening from bypass ratios of zero to the maximum permissible while maintaining ramjet ignition. The modular design of the valve is highly recommended as it promotes its integration on current and future missile systems. If electrical power is required, an independent power supply is preferred. A successful proposal will address these four areas: bypass valve design, actuator design, internal airflow efficiency, and power management. This proposed research project is expected to lead to a state-of-the-art device that will advance supersonic missile technologies and defense capabilities.

Current Specification:

- Mach range: 2-5
- Altitude: 3-70 Kft msl
- Temperature: Up to 2000 F
- Pressure: Up to 400 psi
- Weight: Low for missile
- Power: Independent Battery (if required)
- Materials: Any

PHASE I: Develop innovative approaches to design an adaptive bypass valve, actuator, and power supply for implementation on an SFRJ missile system. Prepare a Phase II plan.

PHASE II: Build and prototype a state-of-the art bypass valve and demonstrate its performance. Mature the transitioning technology during this interim technology maturity phase, depending on the Acquisition Program Office (PMA) requirements.

PHASE III DUAL USE APPLICATIONS: Integrate the Phase II-developed bypass valve prototype on a supersonic SFRJ missile system and flight test the complete system. Transtion the integrated technology to acquisition programs.

Dual uses of the developed technology may include space explorations, martian ramjets, and interstellar ramjets.

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KEYWORDS: Propulsion; Solid Fuel Ramjet; SFRJ; Supersonic Missile; Adaptive Control; Throttling; Weapon Range Extension

N252-083 TITLE: Novel High Performance and Multifunctional Sandwich Composite Structures

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials

OBJECTIVE: Develop advanced sandwich composite structures with improved bond strength and multifunctionality via performance driven design customization.

DESCRIPTION: Sandwich composites are high-performance structures due to their lightweight, high strength-to-weight ratio, impact resistance, and high specific energy absorption capabilities. Honeycomb sandwich composite materials are specifically utilized in both aerospace engineering and marine engineering applications. The performance of the sandwich composite structure is dependent on the type and material selection of the core and face-sheets. In conventional sandwich structures, the core provides compressive and shear strength, and the face-sheets provide bending strength and energy absorption capacity. Core and face-sheet interface debonding is a common failure observed in sandwich composite structures. Current fabrication methods are operating within a limited design space that cannot provide a rational load path for complex geometries subjected to multiaxial loading.

The Navy seeks development of advanced sandwich composite structures with improved bond strength and multifunctionality via performance driven design customization. Innovative core and joining method designs are essential to increase the load-carrying capability without penalizing weight, cost, and fabrication time. Existing 3D printing technology can produce complex core topologies but increasing bonding strength between the face-sheets and core is still an obstacle. The design of the core with improved interface bonding provides a unique challenge and opportunity to develop novel sandwich composites structures.

PHASE I: Develop high-performance sandwich composite structures that have improved bond strength. and additively manufacture different cellular cores with optimized designs. Demonstrate at least one multifunctional capability of the developed structure. The core materials to be used should have comparable properties to aluminum or Nomex cores. Conduct numerical modeling for the optimization of process parameters such as laser power, laser scan speed, and powder feed rate. Perform mechanical tests like edge wise compression, flat wise tension, climbing drum peel, impact, open-hole compression, and compression after impact to demonstrate the desired performance reliability of the sandwich structure. Also, evaluate the structural performance using unit-cell based modeling and simulation. Incorporate a digital technique like machine learning to develop a model to optimize structural performance and process parameters.

The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Optimize the structural performance, design, and process parameters. Manufacture curved and complex sandwich composites based on the optimized cellular configuration. Conduct mechanical tests for performance evaluation. Expand the unit-cell modeling and the developed machine learning model. Compare the functionality and durability of the multifunctional prototype with a conventional baseline part.

PHASE III DUAL USE APPLICATIONS: Develop and manufacture a representative sandwich composite for naval aircraft and conduct testing to demonstrate its multifunctional capability and that the mechanical performance of the component meets or exceeds that of a conventional sandwich structure. Coordinate with industry partners that are manufacturing sandwich composites to facilitate the utilization and transition of the proposed technology.

The proposed technology can be integrated into rotorcraft and fixed wing aircraft with sandwich structures as direct replacements. These sandwich composites will not only have increased performance compared to conventional sandwich structures but will supplement their known benefits with additional multifunctional capabilities.

This technology will allow aircraft manufacturers to utilize and apply the benefits of this developed additive manufacturing process to critical and complex aircraft sandwich composites.

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KEYWORDS: Multifunctional sandwich composites; Cellular composite core; Composite core bonding; Additive manufacturing; Numerical modeling; Mechanical testing

N252-084 TITLE: 400 Gigabit High Speed Data and Video Communications

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Network Systems-of-Systems;Integrated Sensing and Cyber

OBJECTIVE: Increase the speed of military aircraft digital data links to 100 Gigabits (Gbts) per second (Gbps) per lane and demonstrate with a 400 Gbps link over one fiber made up of 4 x 100 Gbps per lane.

DESCRIPTION: The growing use of direct digitization receivers and transmitters on military aircraft is leading to high-speed data rate requirements that are outpacing current aircraft datalink development efforts. Presently, naval aircraft fiber datalinks utilize Vertical Cavity Surface Emitting Laser (VCSEL) technology over multimode fiber, which is both cost-effective and temperature-insensitive at low-data rates. However, as data rates rise, the effects of modal dispersion over temperature are causing VCSEL technology development to reach its maximum achievable performance. Recent NAVAIR receiver designs that employ multiple channels of direct digitization are demanding data transport rates in excess of 700 Gbps. To meet this requirement, the existing 10 Gbps/fiber datalinks would need to be bundled with 70 fibers, while current development of 50 Gbps data links would necessitate 14 fibers for one link. The objective of this SBIR topic is to develop and demonstrate a 4 x 100 Gbts solution that is hardened to meet the environmental requirements for military aircraft. Ideally the technology would have the potential to achieve 200 Gbts in future development programs. This would fulfill a 700 Gbps requirement with only 2 fibers and would generate technology margin for future data speed increases up to terabit data rates. The current state-of-the-art commercial data link solutions use 100 Gbps data lanes with ongoing research and development into 200 Gbts data lanes; however, the primary application is indoor data center operations. These devices are unable to meet the extreme temperature and vibration requirements for military aircraft.

Key Performance Parameters for this topic are:
Demonstrate a maximum BER of 10^-12 between two TX/Rx transceivers under the following conditions:
Data Rate: 400Gbt using 4 x 100 Gbt data lanes
Operating Environment:
Operational Temperature: -55°C to 70°C Continuous, +85°C for 10 min
Thermal Shock: 70°C to -55°C at a rate of 35°C/min
Data transport: distance: 50 m Power Budget: > 15 dB
Vibration: To be provided after award

Technical challenges include:

1. The rate of modal dispersion in multimode fiber increases significantly with temperature, posing a difficulty in maintaining a 100 Gbt link performance at extreme temperatures. VCSEL technology has been the leading choice for aircraft datalinks due to its minimal size, weight, and power (SWaP) and wide temperature operation. However, as the demand for higher speed at high temperatures grows, better performance requires adding increasingly complex and power-hungry digital equalization to achieve marginal speed improvement. As a result, other technologies are sought that meet current and future performance requirements in a similar SWaP to VCSL transceivers and offer a clear performance growth potential to adding additional lanes and faster lanes (200 Gbts).
2. 100 Gbt waveforms require a higher signal to noise ratio (SNR) than slower waveforms. However, due to the presence of multiple bulkhead connections in an aircraft datalink, the power budget must be designed to > 15 decibels (dB). The higher SNR requirements of 100 Gbt combined with the power budget may be difficult to achieve with existing VESCL technology.

3. Data links on current aircraft are exclusively multimode; there is a legacy of deployed support equipment for multimode fiber that makes multimode solutions more likely to be adopted but does not preclude single mode solutions with a compelling performance improvement.

PHASE I: Design and model the link, and if possible, demonstrate the key technologies that will enable the data link to function over temperature. Develop and demonstrate the feasibility of a 4 x 100 Gbts solution that is hardened to meet the environmental requirements for military aircraft and ideally with the potential to achieve 200 Gbts in future development programs. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and deliver six transceivers. Test two packaged transceivers and use these transceivers to demonstrate acceptable performance over the full range of thermal shock and vibration.

PHASE III DUAL USE APPLICATIONS: Support the DoD in transitioning the proposed receiver to include working with a program office to develop a final packaging design that meets the platform SWaP and environmental requirements and developing systems specifications for the associated analog photonic links.

Development of this receiver has widespread commercial applications for high-speed commercial networks in stressing environments.

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KEYWORDS: Transceiver; Ethernet; 100 Gbt; Network; Fiber; Multi-mode; Single mode

N252-085 TITLE: Development of Safe, Robust, Sodium-Ion Battery for Naval Aviation

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Renewable Energy Generation and Storage

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design and develop a sodium-ion (Na-ion), secondary, battery solution for use across manned and unmanned aircraft that meets the environmental, operating, and storage conditions of Naval Aviation battery systems; provides increased safety over current lithium-ion battery solutions; and leverages domestic materials supply chains.

DESCRIPTION: U.S. Navy and Marine Corps currently fields lead-acid (Pb-acid), nickel-cadmium (NiCd), and limited lithium-ion (Li-ion) batteries for use across aviation platforms. Pb-acid and NiCd batteries have significantly lower energy density and service life than currently fielded Li-ion batteries used in the commercial electric vehicle market, resulting in negative impacts to aircraft performance and readiness. While Li-ion batteries are significantly more energy dense than legacy chemistries, the potential for thermal runaway events, high cost, and supply chains reliant on foreign entities of concern (FEOC) create safety, cost, and availability risks to programs. Na-ion batteries offer improvements to energy density comparable to Li-ion solutions while utilizing materials abundant domestically and abroad and may offer significant improvements to safety due to their wide thermal operating envelope. Na-ion batteries are currently in development and fielded commercially by FEOCs abroad.

The objective is to design and develop a sodium-ion (Na-ion), secondary, battery solution for use across manned and unmanned aircraft that meets the environmental, operating, and storage conditions of Naval Aviation battery systems, provides increased safety over current lithium-ion battery solutions, and leverages domestic materials supply chains. Therefore, the intent of this SBIR topic is to develop a Na-ion battery that can meet the harsh environmental operating and storage conditions of Naval Aviation battery systems while providing weight and energy savings to the platform with safety improvements and leveraging the materials required in the domestic supply chain.

PHASE I: Define and develop a concept for feasible battery designs including requirements compliance matrices and defined trades. Determine the feasibility of a Na-ion battery design that leverages requirements from multiple, Navy-led, battery commonality efforts that are traceable to systems engineering models of the MIL-PRF-29595 General Specification for Aircraft Rechargeable Lithium Batteries [Ref 3], its associated slash sheets, and small unmanned aerial systems (sUAS) battery designs. Develop a preliminary design review (PDR) level design and recommended validations leveraging the S9310-AQ-SAF-010 Navy Lithium Battery Safety Program [Ref 4] and MIL-PRF-29595 performance specification modified for a Na-ion battery systems.

The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop five (5) prototype Na-ion batteries to validate improvements to performance, including weight savings, across operational and storage environmental envelopes. Demonstrate use of the domestic materials supply chain by providing relevant bill of materials (BOMs) for prototypes, as well as outlook on future domestic materials supply chain required for Na-ion battery components. Provide report of validation findings and supply chain analysis to Navy customers and program offices that demonstrates benefits of Na-ion over commercial Li-ion solutions.

PHASE III DUAL USE APPLICATIONS: Develop thirty-one (31) batteries for qualification testing to the S9310-AQ-SAF-010, MIL-PRF-29595 and designated slash sheet, MIL-STD-461, MIL-STD-704, MIL-STD-901, and MIL-STD-167 specifications and instructions for successful aircraft and ship integration. Develop four (4) additional batteries for use during flight test and demonstration for transition to the application platform identified in Phase I.

To date, no Na-ion main ship aircraft battery has been developed for commercial aviation. The Na-ion battery benefits of weight savings while providing robust performance and safety across a wider envelope than Li-ion solutions may be transferrable to commercial aviation. Additionally, if Na-ion solutions cannot meet space, weight and power (SWaP) requirements for use in aircraft, the technology can be transitioned to efforts supporting electrification of Ground Support Equipment (eGSE), Uninterruptable Power Supplies (UPS), and grid energy storage domains.

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KEYWORDS: Sodium; Sodium-ion; Battery; Main Ship Battery; Lithium; Lithium-ion

N252-086 TITLE: Multimode Fiber Optic Multiplexer/Demultiplexer

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;FutureG;Integrated Network Systems-of-Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and package uncooled fiber optic multiplexers and demultiplexers for integration into digital fiber optic transmitters, receivers, transceivers, fiber optic backplanes, OpenVPX circuit cards, and light source and power meter test equipment.

DESCRIPTION: Current airborne military (mil-aero) core avionics, electro-optic, communications, and electronic warfare (EW) systems require ever-increasing bandwidths while simultaneously demanding reductions in space, weight, and power (SWaP). The effectiveness of these systems hinges on optical communication components that realize high per-lane throughput, low latency, and large link budget, and are compatible with the harsh avionic environment.

As digital avionics fiber optic transmitter rates increase from 10 Gbps to 100 Gbps and higher, new fiber optic multiplexer/demultiplexer devices will be required. Key enabling components for use in transmitters, receivers, optical backplane, OpenVPX circuit cards, and fiber optic maintenance and troubleshooting test equipment are 50 micrometer core compatible fiber optic multiplexer/demultiplexer devices. The multiplexer/demultiplexer will be integratable with transmitter and receiver optical subassemblies and fiber optic test equipment optical subassemblies. The optical subassemblies are expected to operate over a -40° to +95° Centigrade temperature range and be less than or equal to one cubic centimeter in volume. The test equipment optical subassemblies will provide a launch condition to enable repeatable optical loss measurements on fiber optic links installed on military aircraft.

PHASE I: Develop design concepts for multimode fiber compatible multiplexer/demultiplexer devices for military digital fiber optic communication and test equipment applications. Demonstrate the feasibility of the multiplexer/demultiplexer designs that meet the objectives described in the Description through modeling, simulation, and analysis, showing a path toward meeting Phase II goals. The Phase I Option, if exercised, will include initial design specifications and capabilities descriptions to build prototype solutions in Phase II. Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Design and develop prototype multiplexer/demultiplexer devices optimized using the results from Phase I. Build and test the multiplexer/demultiplexer devices in transmitter, receiver, and test equipment optical subassemblies. Show operation over the full avionics transmitter and receiver temperature range, and the test equipment temperature range. Perform highly accelerated life testing showing a path toward achieving Technology Readiness Level (TRL) 6.

PHASE III DUAL USE APPLICATIONS: Further advance the technology to higher TRLs and demonstrate on flight and support equipment hardware.

The developed technology will be applicable to data center and computer networks requiring wide temperature range fiber optic communications.

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KEYWORDS: Digital fiber optic communications; Avionics; Short Wavelength Division Multiplexing; SWDM; Transceiver; Packaging; 100 gigabits per second and higher.

N252-087 TITLE: Repair Solution for Optically Transparent Canopies and Windscreens

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Sustainment

OBJECTIVE: Develop a repair solution to address scratch and pitting damage to acrylic transparencies or their transparent coatings that is usable within optically critical zones, is executable on-aircraft by intermediate or organizational level maintainers, and decreases aircraft downtime compared with component replacement or depot-level overhaul.

DESCRIPTION: Scratches and pits to the acrylic outer ply of canopies and windscreens cause optical distortion as well as structural vulnerability, and these types of damage cause significant readiness degradation. Currently, available repair methods are costly, time-intensive, and extremely limited in the scope of damages that can be addressed, such that damages greater than 10 mils (measurement of unit thickness) in depth are essentially unrepairable. Furthermore, the optical requirements of canopies and windscreens are exacting, and repairs to transparencies must meet the original optical requirements of the components without inducing even minor distortion. The requirements for the baseline material can be seen in the military specification, MIL-PRF-25690 [Ref 2]. Novel repair materials and processes are needed to facilitate optically acceptable repairs larger than the current state of the art. Candidate repair concepts will be compatible with acrylic substrates, executable on aircraft, optically transparent in accordance with baseline aircraft requirements, able to endure in aval aircraft environments, and capable of being inspected for acceptability to existing standards using existing or novel inspection techniques.

PHASE I: Define and develop a repair material or concept that meets the requirements listed in the Description. Perform analysis to determine feasibility of the concept.
The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and demonstrate a prototype kit and/or process that meets the requirements listed in the Description. Prototype testing and demonstration will be performed at the canopy shop at Fleet Readiness Center Southwest – North Island.

PHASE III DUAL USE APPLICATIONS: Perform final testing at organizational and intermediate level repair locations, and transition for use on H-53 and/or F/A-18. The developed technology will also be applicable to commercial aviation and general aviation.

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2. “MIL-PRF-25690 Plastic, Sheet and Formed Parts, Modified Acrylic Base, Monolithic, Crack Propagation Resistant.” https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=18093

KEYWORDS: Transparency; Acrylic Outer Ply; Canopy; Window; Windscreen; Repair; Optical Zone; Scratch and Pit Repair

N252-088 TITLE: Advanced Artificial Intelligence/Machine Learning-based Intelligent Agent for Finite Element Modeling of Aerospace Structures

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Sustainment;Trusted AI and Autonomy

OBJECTIVE: Develop an advanced Artificial Intelligence/Machine Learning (AI/ML)-based intelligent agent to automate the generation, prediction, and optimization of finite element models, with the ability to accurately account for model errors, enhance modeling fidelity, and reduce user input bias.

DESCRIPTION: Finite Element Analysis (FEA) is a critical computational tool used across a spectrum of engineering disciplines, including, but not limited to, automotive, aeronautical, civil engineering, and biomedical engineering. FEA enables the prediction of the behavior of materials and systems in response to various physical effects such as mechanical stress, strain, heat transfer, fluid flow, and electrostatics. This computational method has empowered engineers with the ability to develop safer and more efficient designs, optimize systems, and predict failure points, significantly reducing the need for physical prototypes and expensive testing procedures. However, the process of building a Finite Element Model (FEM) is subject to multiple sources of errors, including discretization error, errors from geometrical approximation, errors due to assumptions in material modeling, element formulation selection, and errors from inaccurately represented boundary conditions. The iterative process related to model development helps to better understand the physics and mechanical behavior in the actual assembled system, and better understanding is the purpose of FEM and FEA. The intelligence gained through the iterative modeling process often reveals complexities and system effects that can and should be added into the model to achieve accurate physical behavior or acceptable calibration to the physical system. While conventional error mitigation strategies such as mesh refinement techniques, manual error checking, and model validation against experimental data do exist, these methods can be time-intensive, require extensive human intervention, and may still result in biased results due to user subjectivity. In recent years, AI/ML methods such as Generative Adversarial Networks (GANs), Deep Reinforcement Learning, Machine Vision, and Artificial Neural Networks (ANNs) have demonstrated significant potential to revolutionize the FEM/FEA fields. These advanced computational methods offer the ability to automate model generation, accurately predict and mitigate modeling errors, and streamline the process, thereby significantly reducing human intervention and the associated subjectivity. However, a comprehensive, integrated framework utilizing these AI/ML methods for finite element modeling, accuracy modeling impact assessment, and model optimization is lacking.

The Navy seeks to develop a comprehensive AI/ML software toolkit that can transform an input geometry list to generate the finite elements and nodes used in the FEM input deck automatically. The toolkit will estimate the accuracy impact, optimize the model parameters for enhanced fidelity, ensure the meshing process matches the problem, be efficient, and be free from user input bias. The Navy seeks a software toolkit that can refine the ML models based on the outcomes of these tests. The goal is to improve the system's predictive accuracy and error mitigation advice. With constant learning and adjustment, the system will progressively improve and adapt to handle more complex and varied finite element models. The successful completion of Phase II will provide an advanced prototype system capable of automatically generating FEM input decks from input geometry lists, assessing accuracy impact, and providing strategies for error mitigation, thus enhancing the fidelity of finite element modeling processes. The envisioned AI/ML software toolkit will be capable of handling complex geometries and boundary conditions, accurately representing material behaviors, and robustly accounting for various physical phenomena. Furthermore, the toolkit will provide a user-friendly interface, streamline the workflow of finite element modeling, and effectively communicate results to the user, enabling them to make informed decisions. The toolkit will encapsulate modern AI/ML techniques such as GANs, Deep Reinforcement Learning, Machine Vision, and ANNs.

The system's capabilities will include detecting and analyzing the source of errors in the FEMs, assessing these errors, and offering insights into how to mitigate them. A comprehensive series of tests will be conducted to assess the performance of the prototype system. These will include various scenarios and geometries to ensure the system can handle a broad spectrum of FEM tasks.

To validate the designed system, a basic prototype is needed to demonstrate the core functionalities. This prototype will facilitate the automation of simple finite models' generation from existing CAD data and demonstrate the potential of AI/ML techniques in predicting and mitigating modeling errors. An example of this would be the impact of element size, type, and transition on accuracy.

Additionally, the small business awardee will develop a detailed verification and validation (V & V) test plan, which will define clear, measurable metrics and benchmarks that can be used to quantitatively assess the toolkit's performance and effectiveness. The plan will also aid in identifying areas for potential improvements and modifications in the following phases.

PHASE I: Develop a concept for an AI/ML-driven software toolkit. Demonstrate technical feasibility of the proposed concept for automating finite element meshing, creating nodes and elements, predicting potential accuracy impact, and optimizing models for improved accuracy and fidelity. Prove feasibility of the proposed concept by first performing in-depth study of the current state of finite element modeling processes and the inherent error sources, including those not addressed by meshing alone (i.e., post-processing methodology, boundary condition errors, misrepresentation of the structural behavior, etc.). This study would guide the design and development of the AI/ML-driven toolkit, ensuring that the toolkit robustly accounts for the most significant error sources. This toolkit will encapsulate modern AI/ML techniques such as GANs, Deep Reinforcement Learning, Machine Vision, and ANNs. The focus would be on creating a road map for how these AI/ML techniques can be integrated and utilized to automate the model generation process, predict potential modeling accuracy impact, and optimize the model parameters.

The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Devise an AI/ML software toolkit. Design and develop a prototype intelligent support system utilizing the AI/ML software toolkit. Focus on effectively integrating these methods into an automated software system that can handle geometric transformations for FEM input deck generation and offer a standardized process without user input bias. Ensure that the toolkit will address the problem of model uncertainty prediction in mixed fidelity FEMs.

PHASE III DUAL USE APPLICATIONS: Transition validated AI/ML modeling toolkit to integrate with existing FE engineering analysis tools.

FEA is widely used in aerospace, automotive, trucking, heavy equipment companies, medical reconstruction in a vast plethora of private sectors. The benefits to the private sector would be confidence in FEA solutions in a variety of domains including structural mechanics, fluid flow analysis, heat conduction, additive manufacturing, electrical and electronics field, bio-engineering, and so forth. The reduction in cost in these fields makes this topic highly beneficial to the private sector. Dropping the costs and turn-around time for analyses will allow additional opportunities for analysis arising from the decreased cost threshold. This toolkit will improve analysis availability across the entire domain of manufacturing.

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KEYWORDS: Finite Element Analysis; Artificial Intelligence / Machine Learning; Solid Structural Mechanics Stress; Preprocessing and Post Processing; Manual Effort and Manual Review; Shape Function and Numerical Integration Points; Particular Stress Regions

N252-089 TITLE: Virtual Agent for Data Fusion and Understanding

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

OBJECTIVE: Conceive and develop a novel artificial intelligence (AI) system—virtual agent—capable of sophisticated data fusion and comprehension, adapted for the Navy's diverse data ecosystem. This virtual agent will be competent to process, explain, and generate actionable intelligence from heterogeneous data sources; thereby augmenting situational awareness and decision-making acumen within the dynamic maritime theater.

DESCRIPTION: The Navy is inundated with data emanating from myriad multiform sources: sensor data from maritime and aerial platforms, intelligence dossiers, maintenance logs, environmental metrics, communications intercepts, and so forth. Human analysts are presented with complex radar and sonar returns mapping physical spaces and threats, detailed textual and visual intelligence reports necessitating advanced linguistic and visual analytics, operational and maintenance data indicative of asset readiness, and critical oceanographic and meteorological data conditioning strategic operations.

The colossal volume and diversity of these data pose considerable challenges in terms of real-time processing, comprehensive understanding, and the distillation of actionable intelligence. Prevailing approaches anchored in generative AI have exhibited only limited success in natural language and image production and are ultimately wrecked on the shoals of complexity that human-level/human-style intelligence uniquely can comprehend. Generative AI models are constitutionally defective by their inability to explain—and not merely predict—patterns in data, which in addition disables them from generalizing across disparate data types.

To transcend these limitations, a paradigm shift towards a hybrid AI approach—synergizing human-style machine learning (ML) with human-style symbolic AI into a neurosymbolic hybrid—is imperative. Symbolic AI, using knowledge graphs, ontologies, and rule-based systems, can endow the virtual agent with domain knowledge and reasoning faculties. This consilience of ML and symbolic AI will empower the agent to integrate and interpret a wide spectrum of data, discern explicit causality from latent correlations, and generate robust, actionable insights. The envisioned virtual agent must thus leverage both advanced non-Large Language Models (non-LLM) ML and symbolic AI to actualize comprehensive data fusion and deep understanding.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Conceive and develop a neurosymbolic hybrid virtual agent. This initial phase comprises the architectural design of the system and the selection of data types (including, but not limited to radar and sonobuoy data). The objective is to construct a nascent model that validates the feasibility of integrating these diverse data streams and generating preliminary insights. Additionally, this phase will encompass

the establishment of evaluative metrics of system performance and the formulation of a scalable development plan for subsequent phases. Reference sources to determine trust/confidence in the system will include external validated knowledgebases and domain-specific training.
The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Build upon the foundational insights of Phase I, advance toward the comprehensive development, rigorous testing, and empirical validation of the virtual agent. Build and refine the algorithms and models, integrate additional data sources, and enhance the prototype system's real-time processing capabilities. Test the virtual agent within realistic Navy operational scenarios to assess its efficacy in terms of accuracy, alacrity, and resilience. Demonstrate the agent's prowess in delivering holistic situational awareness, anticipating potential threats, and proffering actionable strategic recommendations. Ensure that the virtual agent is a deployable system that substantially augments the Navy's data fusion and understanding capabilities, thereby elevating operational efficacy and strategic decision-making.

Work in Phase II may become classified. Please see note in Description paragraph.

PHASE III DUAL USE APPLICATIONS: Complete final testing. Perform necessary integration and transition for use in operational applications with appropriate platforms and agencies, and future combat systems under development.

Commercially, this product could be used to enable security monitoring, smart city operations center, power grid monitoring, and wherever large amounts of sensors or inputs are utilized.

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KEYWORDS: Data fusion; artificial intelligence; machine learning; AI/ML; virtual agent; neurosymbolic agent; decision-making; symbolic AI

N252-090 TITLE: Second Order Acoustic Vector Sensors

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Network Systems-of-Systems;Integrated Sensing and Cyber;Microelectronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate an increase in acoustic performance via second order vector sensors for use in advanced sonobuoy arrays to track and localize stealthier targets within a larger search area to increase success in future U.S. naval anti-submarine warfare operations.

DESCRIPTION: The application of second order acoustic sensors is employed to great effect in commercial acoustic products such as hearing aids. The U.S. Department of the Navy seeks to explore the application of similar second order directional receivers in sonobuoys to increase overall system performance in air Anti-Submarine Warfare (ASW) operations.

Historically, sonobuoys utilized a variety of approaches to achieve first order directional channels, including acceleration, pressure gradient, and multi-mode sensors. The main advantage of a higher order directional acoustic channel is increased directivity index, which also results in a more complex beam pattern compared to the conventional first order channel. Together, these attributes provide an opportunity to increase overall array gain in complex real-world acoustic environments.

The advantages offered by higher order directional receive channels are fundamentally enabled by increasing the number of receiving channels and then combining them in a beamformer based on the expected acoustic propagation for the sensor configuration. As is true in most acoustic products, sonobuoys must balance these potential performance gains against the targeted unit production cost and limited available volume. Other challenges such as build variances, channel self-noise level, and signal processing power consumption must be addressed to form higher order directional channels. This SBIR topic is interested in developing equally spaced vertical line arrays of second order vector sensors with a center frequency at 1000Hz and a bandwidth of 400 Hz, and with a center frequency at 8kHz and a bandwidth of 1.5kHz. This SBIR topic will determine the number of second order vector sensors that can be packaged in an A-size sonobuoy. The self-noise of each individual second order cardioid will be equal to or less than 30 dB. The array self-noise will be reduced by 10 log of N where N is the number of elements in the array. Approaches must allow for continuous beam steering in in azimuth.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop, design, and demonstrate feasibility of candidate second order directional sensor configurations and associated beamforming approaches that offer performance advantages for sonobuoys in one or more aspects of the overall air-ASW mission. Predict overall performance and offer mitigations to various design challenges. Compare the candidates and down select to a notional design to build and test in Phase II. Demonstrate that chosen candidates can eventually be scaled to fit into an A-size sonobuoy package with considerable effort.

Perform in-depth modelling during the study and identification of possible candidates. Conduct some initial testing to demonstrate the raw material and/or hardware needed to build the candidates for Phase II possess the characteristics used for modeling or that at least the component has the characteristics and performance required for the system to achieve the objectives.

The Navy seeks proven candidate(s) that have been demonstrated and validated to meet the objectives and can be scaled down to fit within the A-size constraints. The small business awardee must provide a full report where their models have been performed with sufficient accuracy and depth to produce meaningful results to meet the objectives. In addition, demonstrate that preliminary testing has been performed on the raw material and/or hardware showing that it possesses the characteristics used for modeling, or that at least the component has the characteristics and performance required for the system to achieve the objectives. The small business awardee must also prove the models and results provided in the report were originated by them.

The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Develop and test prototype(s) of the second order vector sensor to verify Phase I performance predictions. Quantify key performance metrics through a combination of laboratory and open water testing. Extrapolate the expected performance for the intended mission(s).
Work in Phase II may become classified. Please see note in Description paragraph.

PHASE III DUAL USE APPLICATIONS: Integrate the second order vector sensor technology into an A-size sonobuoy, leveraging the prototype fabricated in Phase II. Conduct a demonstration and characterize mission performance under real world conditions.

The new approaches developed in this SBIR topic could enhance acoustic sensing technologies for harbor and port security, marine conservation, and other research or monitoring applications.

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KEYWORDS: Undersea sensor; Acoustic; Vector sensor; Second order beamforming; Sonobuoy; Arrays

N252-091 TITLE: Holistic Inflight Variable Employment Suite (HIVES)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Human-Machine Interfaces;Integrated Network Systems-of-Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Augment existing End-User Development (EUD) based Situational Awareness (SA) tools to support continental United States (CONUS) planning/training and outside the continental United States (OCONUS) planning/mission execution matching existing commercial tools (ForeFlight/Aero) with minimal impact when transitioning from both employment scenarios.

DESCRIPTION: At this time, Commercial Civil Aviation tools to streamline mission plan generation, submission, and mission execution are physically separate from military SA tools used during mission execution. This results in duplication of hardware, increased training requirements, and significant workflow for training vs employment missions.

Existing civil planning tools lack detailed models for military aircraft. Leveraging existing Aircraft, Weapons, and Electronics (AWE) and aircraft Joint Mission Planning System (JMPS) models may allow rapid addition of legacy military aircraft to robust flight planning tools. Layering tactical use of terrain and threat avoidance adds significant complexity to the final output of civil planning tools, tradeoffs for complexity, tactical utility, and flight safety must be explicitly addressed for phase 2 implementations. The objective of this SBIR topic is to augment existing EUD-based SA tools to support CONUS planning/training and OCONUS planning/mission execution matching existing commercial tools (ForeFlight/Aero) with minimal impact when transitioning from CONUS/training to OCONUS/employment scenarios. The tool will encompass pre-flight planning, submission/ingestion of planning data, takeoff/landing performance, mission execution, and mission modification. The resultant mission planning augmentation will combine the best capabilities of both civil and military ecosystems. Successful implementations will integrate International Civil Aviation Organization (ICAO) flight plan submission and JMPS AWE capabilities. Data ingestion from both Automatic Dependent Surveillance Broadcast (ADS-B), Traffic Information Service Broadcast (TIS-B)/Flight Information Service Broadcast (FIS-B), and military data links to provide SA in all scenarios will enhance common functionality across the spectrum of employment. The ability to submit flight plans to civil and military authorities as well as tactical threat warnings will highlight the power of a single tool supporting CONUS and OCONUS implementation. Leveraging FIS-B and DoD GRIB2 weather data will minimize the disparity in environmental SA between deployed and garrison missions. DoD GRIB2 is a standard format for sharing gridded binary data used by the department of defense. The ability to import commercially available approach plates and National Geospatial-Intelligence Agency (NGA) sourced data seamlessly in a single interface will approach the goal of a single carry-on device for both training and operational environments.

Blending DoD and civil data sources will provide robust and timely data for aircraft personnel. While commercial repositories of approach plates may surpass the fidelity of NGA sources, emergent, contingency airfields will only be available through DoD sources. Providing a single, common interface to both sources will streamline all aspects of aircraft employment.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Identify minimum common civil capabilities to integrate into selected SA systems. Identify current DoD processes matching mission plan generation/submission in civil environments. Identify mission data sets available from civil and DoD sources with pathways to integration for each required data set in both peacetime and wartime employment. Develop a consensus for required functionality across disparate aircraft to gauge the difficulty of the overall effort as well as additional “per minimum data set” workload to support disparate aircraft across the fleet. Integration points on both Civil aviation and DoD. The Phase I effort will include prototype plans to be developed under Phase II.

PHASE II: Augment selected SA systems to meet the minimum requirements identified in the Phase I effort.
Work in Phase II may become classified. Please see note in Description paragraph.

PHASE III DUAL USE APPLICATIONS: Focus on the deployment, sustainment, operational readiness, and long-term support for the capability/product developed in Phase II.
This project is a more holistic approach to flight/mission planning in a hybrid environment/battlefield.

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KEYWORDS: Advance Mission Planning; Electronic/Virtual Flight Bag; Electronic Kneeboard; Flight Management; Mission-critical Flexibility; Common interface

N252-092 TITLE: [DON has removed topic N252-092 from the 25.2 SBIR BAA]

N252-093 TITLE: Ambient Acoustic Noise Cancelling for Military Boom Microphones

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Network Systems-of-Systems

OBJECTIVE: Design device(s) that will provide cancellation of ambient acoustic noise in the electrical signal from a military boom microphone.

DESCRIPTION: Microphones operating in high-noise environments transmit a significant amount of ambient acoustic noise to the ear in addition to the desired speech signal. This results in higher, and potentially damaging, at-ear noise levels and reduced speech intelligibility.
Reducing acoustic noise carried in the electrical microphone signal will lower at-ear noise levels and improve speech intelligibility.

There is currently no capability in military aircraft to prevent undesired acoustic noise from entering the boom microphones along with the desired speech signal. The noise is transmitted as part of the electrical signal to the communication system and on to the ear. Noise cancellation technology exists for low-noise environments, such as call centers. Technology needs to be developed for the communications systems and high-noise environments of military aircraft. Solution(s) may include an add-on item in line with the existing microphone or microphone and preamplifier and/or replace the existing microphone or microphone and preamplifier.

Solution(s) must be suitable for military aircraft operational use and hardened for the shipboard EMI environment. Noise cancellation is expected to cover the entire operational frequency range of a standard military microphone and preamplifier.

Device(s) must be compatible with existing aircraft communication systems, listed in terms of priority, which provide either:

1. 28 VDC to preamplifier (MIL-A-23595D or similar) and 5 Ohm dynamic microphone (MIL-PRF-26542-2E or similar)
2. 10 VDC to integrated 150 Ohm electret microphone-preamplifier (MIL-M-49199A or similar)
3. No power; 5 Ohm dynamic microphone (MIL-PRF-26542-2E or similar) connected directly to communication system (Solution may be submitted for a subset of these options)

It is preferred that the device(s) be powered by existing aircraft power. If battery power is included in the solution, the device must not degrade the communication signal if battery fails.
Increase of weight on the head shall be no more than 50 grams. Priority will be given to designs that minimize weight. There shall be no increase in forward center of gravity offset of the system compared to legacy. Additions or changes to boom microphone shape or size must not degrade user visibility.
This topic aligns with PMA-202 focus area: Improved Aircrew Communication.

Deficient speech intelligibility can lead to errors and omissions in time-critical acts, which jeopardize flight safety and mission success. High intensity ambient noise during aircraft operations, which enters the communications system via the microphones, circumvents hearing protection.
1. Compatible with/adaptable to current flight helmets and communications gear
2. Independent of aircraft communications electronics and radios

Note: NAVAIR will provide Phase I awardees with the appropriate guidance required for human research protocols so that they have the information to use while preparing their Phase II Initial Proposal. Institutional Review Board (IRB) determination as well as processing, submission, and review of all paperwork required for human subject use can be a lengthy process. As such, no human research will be allowed until Phase II and work will not be authorized until approval has been obtained, typically as an option to be exercised during Phase II.

PHASE I: Design and build a functional prototype that provides ambient acoustic noise cancellation of the transmitted electrical microphone signal. Verify that the design can reduce pink noise with and without tonal components. Determine the noise reduction achieved in each 1/3 octave band. Verify that the speech signal is not degraded. The Phase I effort will include prototype plans to be developed under Phase II.
Note: Please refer to the statement included in the Description above regarding human research protocol for Phase II.

PHASE II: Build and deliver operational prototypes suitable for the U.S. Navy to conduct flight testing. This will include validating the design reduces aircraft noise and determine noise reduction achieved in each 1/3 octave band and at tonal frequencies and conducting speech intelligibility testing relative to M-87 microphone and EMI testing.
Note: Please refer to the statement included in the Description above regarding human research protocol for Phase II.

PHASE III DUAL USE APPLICATIONS: Flight test, finalize design, and deliver production units. Transition to PMA-202 and add devices as approved items in the Aviation-Crew Systems, Aircrew Personal Protective Equipment Technical Manual.

Noise cancellation of a transmitted electrical microphone signal can be used for any head mounted microphone in a high- or extreme-noise environment. Device(s) can be used or adapted for use in general aviation aircraft.

REFERENCES:
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2. "MIL-A-23595D, Performance Specification: Amplifier, Audio Frequency, August 28, 2019." https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=16444
3. "MIL-PRF-26542/2E, Microphone and Microphone Assemblies, M87/AIC, M26542/2-01, M26542/2-02, M26542/2-03, and M26542/2-04, June 14, 2019." https://store.accuristech.com/aia/standards/mil-mil-prf-26542-2e?product_id=1454946&srsltid=AfmBOoqA2joMqGwf2X3hHpelbJHUuzzqBHJZ7CvClXhuPGdjbd7TEqDq
4. "MIL-M-49199A, Microphone, Linear M-162/AIC General Specification for, June 4, 2024." http://everyspec.com/MIL-SPECS/MIL-SPECS-MIL-M/MIL-M-49199A_54201/

KEYWORDS: Microphone; Noise cancelling; Noise cancellation; Noise reduction; Speech intelligibility; Communication

N252-094 TITLE: Cue Aggregation Algorithms for Multi-function Receivers

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Sensing and Cyber;Trusted AI and Autonomy

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Invent and develop a set of new algorithms expressed in machine learning (ML) form running on commercial off-the-shelf (COTS) processors that can both aggregate multiple signals into classes of same pattern of emission and locate methods to distinguish look-alike signals from platforms with different spectral signatures or different intentions.

DESCRIPTION: When ML is used to locate new radio frequency (RF) energy associated with specific classes of signals in a wideband receiver architecture from within the digital representation of the electromagnetic (EM) spectrum collected by the antenna, the software module only responds to the signals it was trained for. While that is often a nuisance as locating appropriate training data and the time to retrain remain significant issues within the DoD, it can also be a virtue. Importantly, the software should alert (cue) only to the signals it was trained for.

If two functionally distinct types of signals are closely matched in the normally used Pulse Description Word parameters, it is plausible to expect their feature space occupancies to be separable but also close together. Thus, the user should be free to train the software to cue as a single report when either is present in the current signal environment or reporting the two signals present separately. Two differently trained copies of the cue generator could first locate all copies of either waveform in the wideband data and then inform the user who needs to know which of the two signals was actually present. For the purposes of this SBIR topic, we call cue generators that aggregate multiple distinct signals into a single cue “association or aggregation processors”.

A second example would be if the training data consists of the same waveform centered over a range of center frequencies. The cues ought to arise out of every occurrence of that waveform independent of frequency. Each cue will still report the actual frequency window of occurrence. Hence if a new association processor is devised that accepts multiple cues from such a frequency agnostics cue generator as inputs, it ought to be able to identify the data’s commonality and discover the connections and similarities between the disjoint in time signals and potentially the guiding principles of their waveform alteration (e.g. their frequency hop patterns).

Thirdly, note that the cue reports include the time of onset and end of a given transmission as well as identifying which trained signal classes appeared. If the separately received signals of the same signal class from two spatially separated antennae are supplied to a single cue generator and are confirmed to occupy the same feature space volume, a time difference of arrival measurement can be produced by aggregating the separate cue reports. Differences in the feature space points could indicate the signal is dominated by a corrupted transmission with a different effective antenna pattern compared to the other signals being compared. This mechanism of testing correlation can be used as the basis for determining

the relative distance to transmitters and watching it evolve in time. Note that this application of cue aggregation processors does not need to be limited to two antenna outputs.
Fourth, it may be desirable to train cue generators for each of the main types of radar signals and one aggregation processor that can recognize all as "radar" as a class so that users wishing to do only comms know to deprioritize all of them.

Relatedly, if the signals associated with a single waveform are used to train an ML algorithm with a tightly defined feature space, it should be possible to train the same algorithm to recognize as related but distinct those signals with nearby feature space localizations, one class of anomaly.

The Phase I proposal needs to define at least one new aggregation processor functionality and a means of demonstrating it in a lab setting within the base effort. The Phase I Option effort shall then begin the Phase II effort by defining and demonstrating additional types of processors. The Phase II may become classified depending on functionalities and GFE data sources provided.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVAIR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Realize the Digital Signal Processing technique. Demonstrate it in the lab on synthetic or collected data during the Phase I Base period. Prepare a Phase II proposal. The Phase I Option, if exercised, will discuss the signal classes to be focused on with the Navy TPOC and begin the preliminary work associated with the Phase II plan.

PHASE II: Work in a collaborative fashion with Navy personnel to develop and demonstrate a set of aggregative processors operating on COTS processors cards during the Phase II Base period. In the Phase II Option, if exercised, integrate these new processors into the DSP libraries and architecture of a software defined, ultrawideband receiver prototype, address any concerns over fielded operations, and demonstrate processor capacities to potential transition sponsors via an outdoor but in CONUS exercise.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Transition the new processors into the soft/firmware libraries of a Program of Record. Support the Navy in transition efforts.

In the civilian market, establish a set of low-cost software defined radios of the Internet of Things (IoT) sort based on the prioritized receiver concept and with a modest set of loaded DSP and specific cue generators. The IoT messages will set the class of signal to be processed at any given time and the cues active at any given time would define the channels offered to the user. An example might be the multi-functionality of modern television industries offering streaming services; broadcast, music, Kindle-like services; appliance control; and interaction with medical sensors and conveyance of information to clinicians, a one-stop shop for RF functions.

REFERENCES:

1. "Digital signal processing." Wikipedia. https://en.wikipedia.org/wiki/Digital_signal_processing
2. Gautam, Ashish. "Complete Guide to Understanding Signal Processing." electronicsforu.com, October 9, 2024. https://www.electronicsforu.com/technology-trends/learn-electronics/signal-processing

KEYWORDS: adaptive waveforms; coordination of disjoint observers; machine learning; synthetic training data; aggregation; feature space signal representation

N252-095 TITLE: AEGIS MK99 T-1348 Radar Transmitter Components Replacements

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop innovative solid-state components replacements for the MK99 T-1348 Transmitter.

DESCRIPTION: The Navy's MK 99 T-1348 Transmitter is comprised of a Radio Frequency (RF) oscillator multiplier, voltage regulator, Control-Monitor subassembly, and other components. The primary function of the T-1348 Transmitter is RF amplification at J and X bands at the required power levels. The T-1348 Transmitter is an electron and microwave tube technology. The voltage regulator is an electron tube device used in the T-1348 Transmitter used to provide regulated body-cathode voltage for the microwave tube amplifier. The RF Oscillator Multiplier is used in the T-1348 Transmitter and is an analog design used in determining the frequencies in support of modern threats, functions, and information requirements of the Fire Control System (FCS) mission. The Control-Monitor subassembly is used in the T-1348 Transmitter and is an analog design used for communication with the Data Converter Cabinet (DCC). The DCC is an external interface to the T-1348 Transmitter. The Control-Monitor provides fault monitoring and control within the T-1348 Transmitter. The Navy seeks solutions that will replace the RF oscillator multiplier, voltage regulator, and Control-Monitor subassembly with modern technologies that maintain or exceed existing functionality and performance parameters for the FCS. Doing so will decrease costs and provide for less manpower in maintaining the system. There are no current commercial technologies that meet these needs.

The solutions must conform to form, fit, and function in the existing enclosure of the Transmitter cabinet. The solution must fit to existing MK99 T-1348 Transmitter installations aboard DDG 51 Class ships, development and tactical sites, and international ships. The solutions must be functionally equivalent to the current design and meet qualifications for shipboard equipment shock and vibration as specified in MIL-STD-810 and airborne noise and electromagnetic interference as specified in MIL-STD-461. Other operating requirements will be furnished upon request. Any improvements beyond current functionality are encouraged and will also be considered.

The solutions must provide for future upgrading in electronic systems and enable organizational level maintenance. They must work with Continuous Wave Illumination Radar technologies and or conversion of microwave/electron tube technologies using a solid-state design. The solutions must also be manufacturable without supply chain issues.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop a concept for MK99 T-1348 Transmitter component replacements and show it feasibly meets the parameters listed in the Description through testing, analysis, and modelling. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver prototype MK99 T-1348 Transmitter components replacements based on the results of Phase I. Demonstrate that they meet the parameters listed in the Description through testing in relevant environments provided by the government.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the prototype components to Navy use. The prototypes will be tested for integration into the AEGIS Weapon System MK99 T-1348 Transmitter such as its interface with the DCC. Requirement traceability will be used to verify design, analysis, and integration into the overall system using systems engineering principles such as Model Based Systems Engineering (MBSE). The integrated system will be validated in its operating environment and its applicability to organizational level maintenance concept. Testing will be accomplished using modeling, simulation, and realistic signals. Describe how the technology will meet Navy needs.
Other dual-use applications include High Power Continuous Wave amplification used in over-the-air radio or TV transmissions.

REFERENCES:

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2. Esbaugh, J. V.; Clarke, M. T. and Maglathlin, G. W. “Haystack Antenna Control System Design Document. Lincoln Laboratory.” Lincoln Laboratory, Massachusetts Institute of Technology, 7 December 2010. https://apps.dtic.mil/sti/tr/pdf/ADA533478.pdf
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KEYWORDS: Microwave tube; Electron tube; Control-Monitor; Solid-State Components; Voltage Regulator; T1348 Transmitter

N252-096 TITLE: Multi-source Data Ingestion for Warfighters

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Trusted AI and Autonomy

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a capability that mines information from authoritative sources and reduces operator workload and errors.

DESCRIPTION: Operators of theater-level command and control systems, such as the AN/UYQ-100 Undersea Warfare Decision Support System (USW/DSS), must consider a wide range of sources when forming recommendations for Fleet operations. Operators currently manually access a range of authoritative sources in search of the best information upon which to base Fleet operations decisions. Creating the required range of reports involves significant effort that can take hours to complete. Research must be done, then data collected, and finally uniquely formatted reports generated that are provided to a range of consumers. During complex wartime operations, this reliance on manual means to access information introduces an error-prone environment and creates a heavy sailor workload.
Current mission preparation requires operators to spend numerous hours searching Secret Internet Protocol Router Network (SIPRNET) websites and various publications. Current information is stored in a variety of different formats, including hardcopy information, websites, platform status information contained in meta-data communicated over USW-DSS, and embedded recording systems. This information is not stored or tagged in a manner that enables operators to perform rapid searches for data analytics. The Navy seeks a technology to mine authoritative data in various stored formats and provide an intuitive user interface for generating accurate reports. This capability will reduce error-prone situations and time involved to make Fleet operations decisions. The desired technology will allow machine learning to search for vital information, allowing the operator to focus on interpretation of data rather than the mechanics of the search process. There is currently no commercial product that will meet the required technological need.

The technology sought must rapidly access and parse data types across different authoritative sources to produce results within an intuitive user interface. The data to be accessed includes USW-DSS recordings, operational information, authoritative intelligence, lessons learned, estimated probabilities from prior maneuvers, and historical and projected environmental data. The user interface must enable users access to this data as they need it, and in the standardized formats required by USW-DSS and connected systems. The data mining capability and user interface must operate at multiple security levels (e.g., Unclassified up to TS-SCI), supported by an architecture that could allow information at multiple security levels to be ported up to the highest level of security required for a specific effort. The technology will enable data from previous missions to be easily recalled and overlaid with current data to show history of deployments for contacts of interest and activity levels.

The data mining algorithm must provide for authoritative data availability to appropriate access privileges. It must also meet current Information Assurance (IA) specifications for classification security. No known commercial application is capable of meeting the Navy’s requirement to mine from authoritative sources across multiple security levels and meet IA specifications.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop a concept for a data mining capability and associated user interface that meets the requirements as stated in the Description section above. Demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly produced by sample testing, modeling and simulation and or analysis. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop, deliver, and demonstrate a prototype data mining capability and associated user interface. Demonstrate the functionality in a series of user designed sprints with fleet operators to refine the user interface for evaluation. The prototype will be evaluated to determine its capability in meeting the performance goals as defined in the Description. System performance would ideally be demonstrated through installation and prototype testing using the cloud-based USW-DSS prototyping infrastructure provided by the government.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the data mining capability and user interface to Navy use. Finalize the software design and algorithm prototype, for evaluation to determine its effectiveness in an operationally relevant environment in USW-DSS. Support the Navy for test and validation in accordance with the IWS 5.0 USW-DSS Peer Review Group.
The technology will have private sector commercial potential for any secure system such as banking and medical information requiring access and analysis of historical information, reports, and trends analysis.

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5. “National Industrial Security Program Executive Agent and Operating Manual (NISP), 32 U.S.C. § 2004.20 et seq. (1993).” https://www.ecfr.gov/current/title-32/subtitle-B/chapter-XX/part-2004

KEYWORDS: Data mining; AN/UYQ-100 Undersea Warfare Decision Support System; complex wartime operations; intuitive user interface; Information Assurance (IA) specifications; history of deployments

N252-097 TITLE: Battle Rhythm Situational Awareness and Tasking

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Trusted AI and Autonomy

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an integrated Artificial Intelligence or Machine Learning (AI/ML) tool for battle rhythm management by operators of theater-level command and control during complex Undersea Warfare (USW) wartime scenarios.

DESCRIPTION: Operators of theater-level command and control systems, such as the AN/UYQ-100 Undersea Warfare Decision Support System (USW-DSS), must handle both simple and complex wartime scenarios. Peace-time training and exercises often lean toward simple scenarios, leaving operators under trained to handle the complexity of battle rhythms that occur during wartime.

Daily battle rhythm events often consist of morning and evening command-level updates and synchronization meetings required to execute planned operations. In low-intensity operations, the battle rhythm may be more deliberate, with daily, weekly, and monthly working groups and boards. During high-intensity operations, the battle rhythm will naturally be accelerated, but commanders and staff may be tempted to accelerate the battle rhythm more than would be useful. Battle rhythms developed during peacetime often do not effectively provide the commander and staff with timely information to make decisions. Inappropriately accelerated battle rhythms lead to operator error and degradation in situational awareness as efforts to provide updates displaces time required to perform sufficient analysis.
The Navy seeks a tool incorporating AI/ML that will support operators through the full range of complexity seen in modern warfare. The technology sought will assist USW-DSS operators in reliably and rapidly conducting battle rhythm tasking, whether during relatively routine operations or the most complex wartime scenarios. This tool does not currently exist in commercial industry.

The desired technology will make use of the range of authoritative data available to USW-DSS, to include bathymetry, sound propagation paths, track information for United States Navy (USN), allies, threats, and any commercial vessels, and planned maneuvers for USN and allied forces. From these data, the desired technology will provide situational awareness to support appropriate battle rhythm tasking, to regularize the balance between providing updates and performing the analysis and planning required to support effective courses of action. It is envisioned that the desired technology could allow machine learning to support a battle rhythm that is responsive to conflict complexity without overwhelming staff to the detriment of force effectiveness. The tool will support situation awareness, enable battle rhythm tasking, and provide a user interface to facilitate these capabilities. Finally, the tool will need to be compliant with existing information assurance (IA) and other cybersecurity requirements.

The Navy is not aware of existing commercial products that can be used to perform the requested battle tempo management support across complex, war-time scenarios, given the need to use authoritative data at multiple classification levels in a manner that complies with existing IA and other cybersecurity requirements.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop a concept for a battle rhythm tool that meets the requirements as stated in the Description section above. Demonstrate the feasibility of the concept in meeting Navy needs and will establish that the concept can be feasibly produced by sample testing, modeling and simulation and or analysis. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop, demonstrate, and deliver a prototype battle rhythm tool and conduct a series of user designed sprints with fleet operators to refine the prototype for evaluation. The prototype will be evaluated to determine its capability in meeting the defined performance goals System performance will be demonstrated through installation and prototype testing using the cloud-based USW-DSS prototyping infrastructure provided by the government
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the battle rhythm tool to operational builds of USW-DSS provided to Fleet operators. Finalize the software design and algorithm prototype for evaluation to determine its effectiveness in an operationally relevant environment. Support the Navy for test and validation in accordance with the IWS 5.0 USW-DSS Peer Review Group.
The technology will have additional commercialization potential for other military command structures and civilian disaster-response and emergency management organizations.

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KEYWORDS: AN/UYQ-100 Undersea Warfare Decision Support System; complex wartime scenarios; battle rhythm; artificial intelligence or machine learning (AI/ML); effective courses of action.

N252-098 TITLE: Flow-Exposed Conformal Array Acoustic Elements

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a shock-hardened, modular, hydrophone for the exterior of flow-exposed hull surfaces, (e.g., the bow array) for better acoustic detection performance and decreased maintenance.

DESCRIPTION: Submarines and other undersea warfare systems (USW) use passive sensor information to develop track information (bearing, range, course, and speed vs. time) of maritime entities. Elements of the submarine bow array within the AN/BQQ-10 submarine sonar system have traditionally been embedded inside the outer hull within a thick layer of material.

While the material has historically provided performance benefits, the position of hydrophones in the traditional design has meant that individual hydrophones, if failed, would require extensive work to repair or replace. Traditional designs have considered each constituent hydrophone to be an element of the whole. This makes replacing or repairing each individual hydrophone prohibitively costly.
The Navy seeks a hydrophone and modular array design and prototype that is formed modularly with surface-mounted hydrophones. This will minimize the cost and complexity of any repairs that might be required after initial installation. The prototype will undergo Navy testing to determine that the design meets the Navy's requirement as a pre-requisite to making a decision to adopt the new design for future Navy arrays. Currently there is no commercial product that meets this need.

Key elements of such a design would be to retain or improve on the performance associated with current hull-mounted hydrophones. An example is the DT-574 hydrophone. Individual hydrophone elements will be replaceable while maintaining hydrodynamic smoothness across the speed range expected of submarine operations. The design will have a rho of 1.03, making the total array either be neutrally buoyant or even slightly positively buoyant . The thickness of the array would need to be no more than 9.5 inches.

The hydrophone should be able to achieve non-degraded pressure-sensing capabilities while exposed to travel induced flow. In addition, the hydrophone will need to survive shock. For flank and sail locations the hydrophone would need to achieve the threshold Shock Grade B qualification. For bow implementation, the hydrophone would need to achieve Shock Grade A qualification.
The technology architecture will be extensible to multiple types of hull arrays. In addition to requiring that the flow-exposed acoustic elements meet minimum lifetimes of numerous years, the Navy would also be interested in processes to assist operators and maintainers to understand how long each element could be expected to last before replacement would be required.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and NAVSEA in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop a concept for a modular hull array architecture and a replaceable surface-exposed hydrophone that meet the Description parameters. Show feasibility through analysis, modelling, simulation, and testing. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop, demonstrate, and deliver a representative prototype of the solution for both modular array architecture and individual hydrophone performance. Demonstrate the prototype meets the required range of desired performance attributes given in the Description. System performance will be demonstrated through installation and prototype testing conducted by the Navy.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the technology to Navy use for hull-mounted arrays for future spirals of a submarine class (e.g., Virginia-class submarines) or a future submarine class (e.g., future SSN). Support the Navy in transitioning the technology to Navy use aboard submarines. Demonstrate and report on performance during laboratory testing. The prototype will be integrated into submarine arrays for which IWS 5.0 develops updates.
The technology could be extended to any passive sensor, including sensors aboard surface ships and unmanned vehicles. The technology would be of greatest use in large or complex arrays where individual hydrophone failures carry disproportionate risk of distorting total array performance, such as arrays for ocean exploration in support of the oil and gas industry.

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KEYWORDS: Hydrophone-based passive array; modular array; undersea warfare systems; DT-574 hull array transducers; neutrally buoyant; surface-mounted hydrophones

N252-099 TITLE: Indirect Laser Detection and Characterization Device

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Directed Energy (DE);Integrated Sensing and Cyber;Microelectronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Design, develop, and demonstrate critical components and elements for a robust, compact, self-powered (rechargeable batteries), advanced optical sensing system for the detection, classification, and tracking of the HEL in a cluttered environment to provide early cueing of self-defense systems in either a man worn, deployed on a vehicle with tiered fixed/mobile networking, and utilizing both unmanned and manned platform concepts. Due to the rapidly escalating threat that high energy lasers present to Armed Forces of the United States, it is desirable to have reliable early warning system for "tip off" alert to lasers being used for sensing or damaging personnel or platforms. This SBIR topic seeks to augment personnel, either a stationary or mobile, or in a tiered capability with a unique optical sensor capable of sensing, warning, identifying, and potentially enabling the automatic use of countermeasures to address threats. The capability also may offer measurement and signature intelligence (MASINT) when mounted on remotely operated or autonomous vehicles.

DESCRIPTION: Due to the rapidly escalating threat that HELs present to the Armed Forces of the United States, it is desirable to have a reliable early warning system for "tip off" alert to lasers being used for sensing or damaging personnel or platforms. This SBIR topic seeks to augment personnel, either stationary or mobile, or in a tiered capability with a unique optical sensor capable of sensing, warning, identifying, and potentially enabling the automatic use of countermeasures to address threats. The capability also may offer measurement and signature intelligence (MASINT) when mounted on remotely operated or autonomous vehicles. Dual sensing sensors, both in visible & near infrared (VIS/NIR), and Short-wave infrared (SWIR) are near term potentials that should be realized, however additional sensing capabilities in the mid-wave and long wave infrared (MWIR/LWIR) wavelengths are also of high interest areas for potential innovation, but believed to be beyond threshold requirements for a man-wearable or man portable system and near-term solution for the initial architecture.

HEL weapons represent a new and disruptive threat to Armed Forces worldwide. The operational attributes of this class of weapon present a unique detection and defense problem. There is a need for advanced sensing to support initial detection ("tipoff"), as well as triggering defensive protective action as well as enabling defensive counter-targeting or countermeasures that inhibit laser weapon effectiveness. A unique attribute of laser weapons is the ability to be silent and potentially invisible to the human eye, resulting in an ability to counter forces from many potential directions, vastly complicating entry or mission capabilities. The potential damage to sensing technologies are problems that increase the potential for mission failure. To be useful, a cost-effective, low false-alarm rate, distributed, early-warning sensing architecture that utilizes “off axis” sensing through coherent light atmospheric scattering of visible, near infrared, short wave infrared, mid-wave infrared, and long-wave infrared is required to provide "tipoff" to alert Armed Forces of and characterize (targeting, sensing, damaging, or lethal) incoming laser threats.

The attributes of such an architecture include, but are not limited to:

a) a passive sensor with off axis (non-direct illumination) laser classification capability that includes wavelength, pulse repetition frequency, waveform and pulse duration,
b) a capability to store and retrieve a time stamped datagram that includes wavelength, pulse repetition frequency, waveform and pulse duration,
c) a capability to relay communications using standard server like networking queries (e.g., Transmission Control Protocol/Internet Protocol (TCP/IP) or User Datagram Protocol (UDP) remote services),
d) a wide field of view (threshold: 120 (+/-60) deg horizontal, -20 to +90 deg vertical; objective: 190 (+/- 95) degree horizontal, -20 to +120 vertical),
e) Long sensing duration (threshold: 24 hours; objective: 72 hours) per charge,
f) Replaceable batteries (e.g., 18650) and externally powered (objective: Universal Serial Bus Type-C (USB-C) connector),
g) a cost-effective and covert platform,
h) small, compact (less than 500cc's, 30 cubic inches), lightweight (less than 500 grams), with ability to be single man portable or wearable,
i) Waterproof (IP67),
j) Operating Temperature of -40 to +65°C ,
k) Sensor Array (SA) metrics for discrimination, image capture, and determination characteristics include, but are not limited to:
    1) Dual sensing sensors, format: 1024 x 1024 (visible & near infrared (NIR)), and 256 vertical x 512 horizontal (Short-wave infrared (SWIR),
    2) Sensing range of 50 meters off-axis (perpendicular) with detection and classification from either a blue, green or red (405, 532 or 880nm) or a NIR/SWIR (1064 or 1660nm) - 50 milliwatt high energy laser source in a clear, unobstructed viewing path with quiescent, non-turbulent atmospheric conditions,
    3) Sensing time and characterization of no more than 0.5 seconds,
    4) Sensor scanning frequency of no less than 60hz (threshold), and
    5) Sensor false alarm rate of no more than 1 per million, including solar rejection.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and ONR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Define sensor requirements in terms of power, volume, weight, noise limitations, motion limitations, and so forth. Identify specific configuration(s) to be included, and develop the strategy and design of integration and scale of the device and attachments. Define a prototype design, operation within a system construct to include the requirements of low detectability, software, and communications to allow the integration of a cooperative, networked sensor array, in either wired or wireless networks.

Reach a demonstratable benchtop device with a prototype design and manufacture plan to be implemented under Phase II.

PHASE II: Develop a prototype device that can perceive, identify, and characterize a laser in an off-axis sensing and perform data collection. Further develop a prototype and demonstrate the prototype or unmanned platform. Perform ground- or sea-based trials data collection of individual vehicles in terms of feature identification performance, operational agility, and accuracy. Perform limited field and/or sea trial to collect test data analysis when mounted on ground-based or airborne platforms.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Complete final testing and perform necessary integration and transition for use in counter-laser surveillance and monitoring operations with appropriate current platforms and agencies and future combat systems under development.
Commercially, this product could be used to enable remote laboratory safety systems, and enable satellite monitoring or laser-based communications.

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KEYWORDS: laser, detection electro-optic; surveillance; classification; remote sensing; Machine Learning; Artificial Intelligence; AI/ML

N252-100 TITLE: Efficient Multiphysics Modeling Framework for Rain-Induced Damage and Aerodynamic Effects on Hypersonic Vehicles

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Hypersonics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and validate automated multiphysics computational tools to accurately predict raindrop interactions with hypersonic vehicles, including droplet-shock interactions, breakup dynamics, flow-field modifications, and thermal protection system (TPS) material damage, while minimizing user expertise requirements and computational costs.

DESCRIPTION: Hypersonic vehicles will encounter various weather conditions, including rain. Raindrops can threaten structural integrity and TPS performance, potentially leading to catastrophic failures [Ref 1]. Rain droplet impacts during flight pose substantial risks to the structural integrity and performance of TPS, potentially leading to catastrophic failures [Ref 1]. Interactions between droplet impacts and the surrounding flow field can disrupt vehicle maneuverability, increasing the risk of loss of control. Existing modeling tools, originally developed for blunt cone geometries, are inadequate for addressing the complexities of modern maneuvering hypersonic vehicles [Ref 2]. New tools are required to simulate droplet interactions with hypersonic shock waves and boundary layers, characterize breakup dynamics, and evaluate flow field modifications.

High-speed droplet impingement is a challenging problem involving a wide variety of physical mechanisms, including aero-breakup and phase change. Modeling droplet impingement at high Mach numbers involves a wide range of physical mechanisms, including material and flow discontinuities, interfacial instabilities, phase change, and turbulence [Ref 3]. Additional complexities stem from the limited algorithms available that can handle high Mach number flows while maintaining a high-order of accuracy, as the variable reconstruction and flux differentiation steps can lead to unbounded volume fractions, negative speeds of sound, or partial densities, requiring positivity-preserving numerical schemes. Advancements in multiphase computational fluid dynamics (CFD) methods have improved the simulation of rain droplet interactions with hypersonic vehicles. For example, diffuse interface multiphase methods provide a simple, computationally efficient, and numerically robust approach to model droplet breakup and impingement [Ref 4]. Additionally, Adaptive Mesh Refinement (AMR) allows for efficient tracking of important flow features such as gas/liquid interfaces, shocks and wakes and the target geometries. Diffuse interface methods, coupled with AMR, have enabled modeling of droplet-shock interactions and instabilities, such as Rayleigh-Taylor (RT) and Kelvin-Helmholtz (KH) [Ref 3]. Integration of CFD with structural solvers like peridynamics has enhanced predictions of material damage during high-speed impacts [Ref 5]. GPU-accelerated multiphase solvers have demonstrated up to 300x speed-ups while maintaining fidelity for shock-droplet interactions [Ref 6].

Experimentally, the effects of weather encounters are difficult to simulate through ground testing. Historically, most knowledge of weather encounters has been provided by flight testing, which has numerous shortcomings such as expense, limited data throughput, and uncertain characterization of the environment. Developments in high-speed diagnostics and advances in experimental campaigns, including electromagnetic-launcher tests, have validated droplet deformation and aerobreakup under hypersonic conditions [Ref 7]. Despite this progress, gaps remain in material modeling, robustness, and aerodynamic impact analysis, limiting current tools.

Challenges persist in accurately modeling advanced composite materials, such as carbon-carbon, including accumulated damage effects like surface roughness evolution and its impact on erosion rates. Debris shielding, where water and material fragments alter subsequent droplet impacts, remains underexplored [Ref 8]. Integrating key physics like phase change and cavitation into robust simulations is critical. Current tools provide limited insight into aerodynamic changes, including forces and moments crucial to vehicle stability. Addressing these gaps requires next-generation tools that leverage GPU acceleration for scalable simulations while fully integrating composite material behavior, shielding effects, and aerodynamic impacts.
The target requirements for this SBIR topic include:

- Robust Multiphysics Integration: Simulate raindrop interactions with hypersonic vehicles, incorporating critical physical phenomena such as droplet-shock interactions, phase change, and arbitrary equations of state, while ensuring computational stability.
- Advanced Material Modeling: Predict the behavior of advanced composite materials, such as carbon-carbon, capturing high-strain-rate responses, crack propagation, and accumulated surface damage. Fully couple the material response with CFD solutions.
- Shielding and Ejecta Tracking: Develop the ability to track ejecta and model shielding effects, including debris impacts on vehicle surfaces and resulting flow field changes.
- Aerodynamic Effects Analysis: Provide predictions of aerodynamic changes, including forces and moments caused by surface deformation, to assess vehicle stability under adverse conditions.
- High Computational Efficiency: Leverage GPU-accelerated architectures and AMR to achieve scalable, high-fidelity simulations for realistic operating conditions.
- Automated Pre- and Post-Processing: Implement workflows for solver setup, grid generation, and data analysis to minimize user intervention.

PHASE I: Develop a prototype multiphysics modeling framework for simulating raindrop impacts on hypersonic vehicles. Incorporate key phenomena such as droplet-shock interactions, breakup, impingement, and material response. Validate using canonical geometries and existing experimental data. Assess accuracy and feasibility. Define a path for platform-independent computation and establish a roadmap for scaling to complex, three-dimensional vehicle geometries. Prepare a Phase II plan.

PHASE II: Develop a fully integrated multiphysics simulation framework for raindrop impacts on hypersonic vehicles. Incorporate advanced material response models, including damage evolution for carbon/carbon. Implement shielding and ejecta modeling, adaptive mesh refinement, and critical physics such as phase change. Validate and demonstrate the framework on realistic hypersonic vehicle geometries using existing experimental data. Ensure efficient operation on emerging computing platforms and implement workflow automation to minimize user intervention, enabling repeatable and high-quality results.

PHASE III DUAL USE APPLICATIONS: Transition the developed simulation framework for raindrop impacts on hypersonic vehicles to practical applications within the Department of Defense (DoD) and commercial sectors. Validate and optimize the framework for a wide range of hypersonic vehicle configurations, materials, and flight conditions. Collaborate with industry partners and DoD agencies to ensure the framework meets deployment standards and operational requirements. Develop comprehensive training programs, user documentation, and technical support resources to enable widespread adoption and effective use by non-expert users.

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KEYWORDS: Hypersonic Vehicles; Multiphase Flows; Droplet Impingement; Shock-Induced Aerobreakup; Weather Erosion; Multiphysics Simulation; High-Strain Rate Response; Adaptive Mesh Refinement (AMR); High-Performance Computing (HPC)

N252-101 TITLE: Environmental Parameters and Transmission Loss Modeling Framework

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Establish a modular software framework encompassing environmental data ingestion, geospatial machine learning, sediment physics models, acoustic simulations, and evaluation metrics for assessing transmission and/or bottom loss in support of anti-submarine warfare (ASW).

DESCRIPTION: To evaluate current and future methods of producing databases of acoustic information, in particular bottom loss, the Navy needs a flexible framework where different datasets, machine learning algorithms, and/or simulations can be “plugged-in” to evaluate their predictive skill. The Naval Research Laboratory (NRL) has produced a codebase, the Global Predictive Seabed Model (GPSM), [Ref 1], that utilizes a subset of methods to produce and evaluate bottom loss databases utilizing environmental observations. However, this framework as it currently exists is strict in its formulation, uses a non-standardized interface, and is less modular than necessary to allow other datasets, methods, and/or models to be easily utilized. Further, the GPSM codebase currently solves the acoustic “forward problem” (environmental observations -- simulation -- acoustic observations) and lacks the flexibility to solve the “inverse problem” (acoustic observations -- simulation -- environmental observations). This gap in capability allows for opportunity to incorporate innovative inversion methodologies, such as trans-dimensional geoacoustic inversion [Ref 2] in the codebase. This innovation will allow acoustic data holdings, such as The Naval Oceanographic Office-collected transmission loss data, to be incorporated into environmental models within a single framework.

The formation of a new framework with a standardized interface is necessary for the development of novel methods and collaboration within the wider scientific and Naval community. The transition of the forward-solver in the current GPSM codebase and the new inversion methodology into this new framework will set the basis of a new system for other researchers to provide data and evaluate methods on an even playing field.

Specifically, this SBIR topic requires: 1) a modularized framework in which the updated GPSM codebase fits; 2) a standardized interface that other researchers can use to formulate code to fit into the new framework; 3) a framework flexible enough to solve both the “forward” and “inverse” problems; and 4) proper documentation and code examples so that future users can utilize the new framework to evaluate past and future methods and datasets.

Note: A Controlled Unclassified Information (CUI) version of the GPSM codebase (able to solve the forward problem) will be provided for use during Phase I.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and

Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and ONR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop a software framework with a standardized interface for the quantitative assessment of global acoustic databases that includes the ability to start with sparse environmental observations and produce transmission loss at various frequencies and evaluate their fit to observed values. Additionally, any innovation plan to solve the inverse problem must fit within this standardized framework. Establish data formats for incoming datasets and dataset outputs to make the framework tractable. Design an interface and glossary to work within the framework and be flexible enough to not dissuade potential future users and researchers. Develop a Phase II plan for 1) incorporating innovative inversion methodologies into the standardized software framework, and 2) implementing, testing, and evaluating the software framework.

PHASE II: Implement the software framework developed in Phase I for the current GPSM codebase. Develop an inverse solution to the acoustic problem, such as trans-dimensional geoacoustic inversion, that fits within the software framework. This updated codebase will serve as the basis for future development and will be the first test of the framework. Evaluate the framework (e.g., ability of others to develop methods to “plug into” the framework). Test and evaluate both inverse and forward methods. Assess documentation to determine usability and flexibility of the framework. Tests between at least two competing data sets and/or geoacoustic models in specific regions of interest, over a wide range of frequencies. This will not only demonstrate the value of the system(s) produced as a part of this SBIR, but also serve to recommend one or more data sets or numerical simulations to the Navy.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Incorporate a wide variety of Navy-standard and publicly available datasets into the new framework and determine their usability within the framework. These datasets include but are not limited to: acoustic transmission loss, backscatter, and geotechnical data like multi-beam and sub-bottom profiler data. The final test of the framework will be an end-to-end evaluation of multiple methods and datasets to evaluate and recommend a new methodology to produce a Low Frequency Bottom Loss (LFBL) to NAVO NP5. The framework developed here will continue to be used to evaluate methods and datasets beyond this SBIR to improve prediction capabilities into the future. Although the specific GPSM codebase would not be available for public use, the software framework and standardized interface developed in Phase I can be applied by the performers to other applications in the private and academic sectors.

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KEYWORDS: Sonar; Submarine; Sensor; Bottom loss; Environment; Inverse modeling; Forward modeling; Geology; Sediment

N252-102 TITLE: Hardware-Level, Reverse-Engineering Resistant Logic Designs for Standard Complementary Metal-Oxide-Semiconductor (CMOS) Processes

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Microelectronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a hardware-based design for standard Complementary Metal-Oxide-Semiconductor (CMOS) processes that stymies a range of common attacks and limits the ability of third parties to understand the functional behavior of fabricated chips.

DESCRIPTION: With the advances in various technologies, integrated circuits have become increasingly susceptible to reverse engineering. De-layering of an integrated circuit, for instance, reveals the interconnections between transistors and permits discerning the behavior of function blocks. This, in turn, enables eventually reconstructing the netlist and hence understanding the behavior of the full system. Adversaries would thus be free to copy the designs for their own uses. They could also probe them for faults and develop countermeasures. If these adversaries can insert themselves into the supply chain, then they would additionally be able to introduce back-doors, kill switches, and other mechanisms into the designs.

Reverse engineering is an especially significant threat to small embedded systems that operate in contested areas. Both commercial and non-commercial entities have shown that integrated-circuit extraction is possible and that those circuits can be successfully reverse engineered even when non-standard, hardware-level encryption is employed. Embedded, on-chip memories are also no longer safe from analysis.

Due to the threat that reverse engineering poses, several groups have proposed integrated-circuit camouflage approaches. These include the incorporation of dummy contacts, vias, and filler cells along with programmable standard cells. However, each of these has substantial issues. Dummy contacts, vias, and filler cells have no physical connections with the actual circuit. They thus do not hinder the de-layering process and serve to only marginally slow the progress of automated tools. Using programmable standard cells is incredibly costly, as it is a non-standard process at most, if not all, semiconductor foundries. As a consequence of these limitations, research has concentrated on the development of diverse logic families that rely on different threshold devices to conceal the hardware. The physical appearance of these devices is identical for different functionalities and is extremely difficult to discern from imaging and de-layering. However, many of the proposed logic families rely on the absolute values of the threshold voltage due to the single-ended configuration. They require external bias voltages to control the switches for proper orientation. Process-voltage-temperature variations can significantly affect these logic families and ultimately cause them to malfunction. Switching between nodes is also highly complicated. The Office of Naval Research (ONR) seeks the submission of SBIR proposals that outline novel approaches for resisting reverse-engineering efforts. These approaches should focus on hardware-based protection mechanisms that are completely agnostic to the chosen application. Any SBIR proposals that include solutions focused either primarily or solely on software-based mechanisms will not be considered responsive to this topic.

There are several requirements for a hypothetical hardware-level obfuscation approach that are found in existing offerings. Some additional research is hence needed. Any proposed approach shall be suitable for both synchronous and asynchronous architectures. The approach shall be implementable in any standard CMOS process without the need for custom masks to both demonstrate basic attack-resistant functionality and achieve reasonably high chip yield rates. Custom masks can be used if they exhibit clear advantages with regard to chip power efficiency, performance, and reliability. To ensure that any proposed approach has broad applicability for transition sponsors and commercial partners, newer nodes shall be targeted. These shall include, at the minimum, either a TSMC 28-nm node or a GlobalFoundries 22-nm node during the first two phases of this SBIR and either a TSMC 16-nm node or a GlobalFoundries 12-nm node in the third phase of this SBIR. The change in nodes is necessary to validate that the approach is mostly, if not entirely, process independent. Regardless of the node, the proposed approach shall demonstrate a clear resilience to imaging-based attacks and de-layering. It shall be impervious to optical, laser, and scanning-electron-microscope sensing modalities along with any similar modalities. It shall also be resistant to side-channel attacks based on time, voltage, and current measurements. Any side-channel measurements should have, at most, a five-percent deviation per operation. Some resistance, if not complete resistance, to laser-fault injection should be theoretically demonstrated and empirically validated. Likewise, some resistance to machine-learning (ML) attacks should be empirically demonstrated. The types of ML attacks will be specified in the third phase of the SBIR. Lastly, there are hard requirements on the number of additional transistors that can be used in any proposed approach compared to the non-obfuscated designs. For an n-input, 1-output Boolean function block, the total number of transistors allowed in the obfuscated design should be either less than or equal to $n + (n + 1) \times 2^{(n - 1)}$. The number of stacked transistors, if used, shall be less than or equal to $n - 1$. These transistor requirements ensure that any proposed approach strikes a reasonable balance between security, silicon area, power, and performance.
Design Requirements: A hardware-based approach that stymies a range of common attacks and prevents, as much as possible, third parties from understanding the functional behavior of chips fabricated using it. This approach shall possess the following traits:

- Cover all Boolean logic within a single functional block with n inputs and a single output, with n being at least four.
- The number of total transistors for an n-input functional block shall be less than or equal to $n + (n + 1) * 2^{(n - 1)}$.
- The number of stacked transistors shall be less than or equal to $n - 1$ for an n-input functional block.
- Implementable in any standard CMOS process for a 28-nm node and below.
- Implementable without the need for custom masks.
- Complete application agnosticity.
- Less than five percent side-channel signature variation per logical operation.
- Usable for synchronous and asynchronous architectures.
- Resilience to vision-based attacks that use various sensing modalities to uncover functional-block and system-level behavior.
- Resilience to side-channel attacks based on time, voltage, and current measurements to deduce functional-block and system-level behavior.
- Partial resilience to common machine-learning attacks that attempt to infer functional-block behavior.
- Partial resilience to laser-fault injection attacks.

Technical challenges: Ideally, the proposed approach should be implementable in only a few more gates, compared to non-obfuscated designs, and therefore offer low-power, high-performance capabilities for a given node.

The proposed approach, and chips fabricated using it, may be used for applications in harsh environments not currently considered by the acquisition program. A path forward for extreme-temperature operating conditions, such as those between -40 C and 120 C, shall be established in the design stage, even if it is not implemented in the prototypes. The chips will not be used in environments where direct contact with water is expected. They will also not be used in environments where either high background radiation, high humidity, high pressure, or some combination thereof, is expected. Lastly, they are not expected to be used in biological organisms.

PHASE I: Outline a hardware-level logic obfuscation approach that is resistant to reverse engineering by optical, laser, and scanning-electron-microscope sensing modalities, reverse engineering by analyzing the routing and metal traces along with the logic architectures, and reverse engineering to side-channel signatures, like timing, current, and voltage. Develop a comprehensive simulation for advanced nodes, such as TSMC 28-nm or below and GlobalFoundries 22-nm or below. Outline the functionality, reliability, and expected yield of the approach, which includes Monte Carlo simulations. Prepare a Phase II plan.

PHASE II: Design, fabricate, verify, and test a simple test chip that uses the proposed hardware-level obfuscation approach. This chip could include, for instance, simple logic gates, adders, and registers. A more complex design shall be considered following the success of this first chip. This could include, for instance, either a 128-bit AES engine or an 8-bit microprocessor. Fabricate and evaluate more than fifty samples, ensuring that a majority of the samples exhibit the desired functionality so as to demonstrate that the approach achieves a high yield and prevents against optical-based and side-channel-based attacks. Build a standard digital library that follows the standard digital design flow. Ensure that this library shall be both timing and place-and-route compatible with existing electronic-design-automation (EDA) synthesis tools like Cadence and Synopsys. Provide a full analysis of power, silicon area, speed, and noise margin compared to standard logic designs for the designs made using this library. Ensure that any chips fabricated using this library are operational within the temperature range specified.

PHASE III DUAL USE APPLICATIONS: Investigate and show a resilience of the proposed approach to attacks that use laser-fault injection reverse engineering and machine-learning reverse engineering. For fabricated chip designs, provide a full analysis of the yield rate and compare to standard logic designs. Once such tasks are completed, develop an automated design compiler for converting existing digital designs to attack-resistant designs for processes such as TSMC 16-nm or below and GlobalFoundries 12-nm or below. This compiler may be created in conjunction with larger industry partners. Work with foundries to develop custom masks to improve performance, reliability, and yield of the proposed secure logic framework, if improvements would offer substantial operational increases. Specify plans to either license the designs or facilitate transition to a major design partner, with the aim to use both the design compiler and standard library in multiple programs of record. Pertinent industries to target during this effort would include mobile device manufacturers, medical device manufacturers, automobile manufacturers, and semiconductor manufacturers. Other relevant industries include those that are involved with designing and producing integrated circuits via a decentralized supply chain and where the risk of intellectual-property theft is high.

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KEYWORDS: Reverse Engineering; Camouflaged Gates; Hardware Obfuscation; Logic Obfuscation; Chip Security; Application-specific integrated circuit; Secure ASIC Design; Secure ASIC Fabrication

N252-103 TITLE: Virtual Sea-Shield -- Immersive Content Creation with Generative AI for Automated C5ISR Situational Awareness

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Human-Machine Interfaces;Integrated Sensing and Cyber;Trusted AI and Autonomy

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an Artificial Intelligence (AI)-driven 4D content generation environment that efficiently processes all-domain Command, Control, Communication, Computers, Cyber, Intelligence, Surveillance, and Reconnaissance (C5ISR) information into high-fidelity immersive observables for collaborative situational awareness across the desired layers of naval operations.

DESCRIPTION: Virtual Sea-Shield (VSS) is an all-domain multilayered protective environment that utilizes AI-assisted automatic situational awareness to deter threats (i.e., jamming, unmanned vehicle attacks, missiles, etc.) from targeting naval assets. VSS is a decentralized 4D (time and space) digital content generation environment for building a self-healing adaptive multilayered defensive and offensive naval sea shield across various naval operations. VSS utilizes generative AI for automated content creation by processing all-source intelligence, operational objectives, and engagement plans. In autonomous operations, VSS can track, penetrate, and trigger automatic strikes on designated hostile assets, personnel, logistics nodes, ammunition depots, and supply lines – blunting adversaries' advances and disrupting its ability to maneuver, regroup, and launch attacks. Above all, VSS is a critical access infrastructure for a novel Autonomous Sea-Basing to support the deployment of forces, equipment, supplies, and warfighting capabilities.

Today, a multidisciplinary team of decision-makers, analysts, and warfighters conduct extensive wargaming exercises with a considerable investment in time and resources as they sift through vast amounts of data to look for indication and warning (I&W) signs and supporting evidence to anticipate and counter adversarial trends, strategies, and tactics that may have unfavorable impacts on the U.S. National Security interests. This human-centric approach to attain proper visibility into future events is fraught with the risk of costly errors, human biases, and omissions of valuable insights that may influence the assessment of evidence, skew statistical analysis, or color the recognition of cause and effect.
This SBIR topic envisions a systematic approach to integrate AI-based immersive technologies into the C5ISR environment with improved accuracy and agility over the current human-centric paradigm. VSS leverages state-of-the-art immersive technologies such as augmented reality (AR), virtual reality (VR), spatial reality (SR), and mixed reality (MR) as extended reality (XR) to transport humans from observation experience to immersion experience as they stimulate human attention to focus on I&W signs of emerging situations. The immersive technologies engage end-users to enrich collaborative teaming through natural language, dynamic visualization, and sound as they navigate spatial domains (i.e., sea, air, land, and space) and cyber. Generative AI-driven MR overlays provide a true-to-life presence and awareness that go beyond simply displaying pre-programmed digital elements. A successful VSS will generate realistic and adaptive content overlays that openly respond to human interactions with the contents and induce collaboration – during which generative AI tools will learn adversarial tactics and anticipate the evolution of engagement scenarios, and their consequences based on human decision-

making effects. By doing so, VSS brings about the synergy between humans and AI. It enables warfighters to home in on deterrence options, experiment with novel human-to-machine (i.e., unmanned aerial vehicle (UAV), unmanned underwater vehicle (UUV), space assets) or machine-to-machine teaming engagement opportunities, conduct joint operations rehearsal, or perform training exercises. The VSS performance test and demonstration applications for the proof-of-concept (Phase I) and prototyping (Phase II) may include operational scenarios that capture a series of hostile joint military and commercial mobilization and exercise activities to control contested waters such as amphibious landing and sea-lane blockade. With generative AI, the immersive VSS must automatically extract knowledge from multimodal datasets to demonstrate creative teaming of the blue forces required to penetrate an anti-access area-denial environment, where and how, with sustainable persistence while inside and outside a contested space. The quantitative metrics must include timely decision-making, and precise command and control for engagement strategies and tactics supported by the layered deployment of forces, equipment, and supplies that signify adaptive sea basing. The Phase I proof-of-concept will be unclassified. AI-assisted creative teaming and collaborations will be limited to unclassified multimodal contents (e.g., text, images, video, audio, spatiotemporal 4D models, or other data types) over commercial 5G networks. The VSS end-to-end design must consider distributed deployment, fault-tolerant connectivity, optimal configuration throughputs, and scalability.

Note 1: Phase I will be UNCLASSIFIED and classified data is not required.
Note 2: Contractors must provide appropriate dataset release authorization for use in their case studies, tests, and demonstrations, and certify that there are no legal or privacy issues, limitations, or restrictions with using the proposed data for this SBIR project.
Note 3: Work produced in Phase II may become classified. However, the proposal for Phase II will be UNCLASSIFIED. The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and ONR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.
Note 4: If the selected Phase II contractor does not have the required certification for classified work, ONR or the related DON Program Office will work with the contractor to facilitate certification of related personnel and facility.

PHASE I: Develop a concept for generative AI models to generate VSS context-relevant content representing naval operational domains (i.e., sea surface, undersea, air, space, land, and cyber). Leverage generative mesh methods to produce high-resolution 3D textures and shades for the virtual world including text-to-3D and multimodal 2D imagery to 3D content. Apply the retrieval-augmented generation method to improve the accuracy and reliability of generative AI models with facts from external sources. Develop domain-relevant common large language models (LLMs) for defining, packaging, assembling, and editing 3D data for digital content creation applications and visualization. Identify training tools to speed up LLMs training and reasoning about unforeseen events (i.e., unknown unknowns). The VSS end-to-end design must consider distributed deployment, fault-tolerant connectivity, optimal configuration throughputs, and scalability. Demonstrate VSS can perform semantic extraction for automated analysis of all-source intelligence, live multidomain intelligence, surveillance, and reconnaissance (ISR) signals, and can learn I&W signs. Demonstrate the VSS performance facilitates novel virtual collaborative teaming configurations (e.g., human-machine and machine-machine teams) to achieve synchronized operational planning and execution at key points in the contested littoral with immersive decision trees that compute engagement plans, options, and risks associated with the ups and downs of operational encounters.

The feasibility study, test, and demonstration must utilize a combination of OSINT datasets, synthetic datasets from DoN, MCML, unclassified AIS maritime traffic, unclassified commercial satellite imagery, or similar. AI-based data mining includes entity extraction (people, places, and objects), relationships, and transactions -- rigorously searched, recognized, differentiated, and organized into groupings of related facts and relations. Accuracy metrics to ingest and classify multimodal data: structured data mining and interpretation - accuracy of 95% over 98% captured content; unstructured data mining and interpretation – accuracy of 90% over 95% captured content. The software validation, verification, and performance consistency must analyze the VSS sensitivity (i.e., true-positive rate), specificity (i.e., true-negative rate), precision (i.e., positive predictive value), miss rate (i.e., false negative rate), false discovery rate, and false omission rate.

Deliverables: end-to-end initial prototype technology. Conduct appropriate T&E of the conceptual system. Prepare a plan for Phase II. Deliver a final report.

PHASE II: Develop a prototype of the immersive VSS from the candidate technologies in Phase I. Test and demonstrate VSS scenarios with representative operational data sources. Demonstrate the immersive human-machine interaction with the scenarios. Validate the VSS execution timelines to meet the Ops-Floor end-to-end operational requirements. Assess prototype's performance against the metrics detailed in Phase I. Conduct an "end-user satisfaction" survey, on a scale of 0 to 5: a) VSS situation understanding that includes events that go dark, disguised activities and maneuvers, dormant or not radiating targets; b) alignment with formal I&W signals; c) alignment with prioritized deterrence and engagement options; d) timeliness for responsive cross-domain decision-making and collaboration; and e) immersive virtual training. Develop a plan for Phase III with a transition path to a program of record (PoR).
Deliver prototype software, systems interface requirements for mobile and stationary devices, design documentation, source code, user manual, and final report.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Advance these VSS capabilities to TRL-7 and integrate the technology into the Maritime Tactical Command and Control PoR or ISR processing platforms at the Marine Corps Information Operations Center.
Once validated conceptually and technically, demonstrate dual-use applications of this technology in the video gaming industry.

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KEYWORDS: Immersive; Artificial Intelligence; Generative AI; Generative Mesh; Virtual Reality; Spatial Reality; Augmented Reality; Mixed Reality; Large Language Models

N252-104 TITLE: Compact Rotary Engine Materials, Coatings, and Architectures for Robust and Reliable Operation in a Marine Environment

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Sustainment

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop advanced materials, coatings, and/or material-architectures, supported by experiment, modeling and simulation, to improve the efficiency, durability, and performance of rotary engines that operate in a marine environment.

DESCRIPTION: The U.S. Navy and Marine Corps has a growing interest in compact and efficient propulsion and power solutions, particularly for applications that demand high power density, operational reliability, and fuel flexibility. Rotary engines, with their favorable power-to-weight ratios and simplified mechanical designs, are well suited for Unmanned Aircraft Systems (UAS) and other compact vehicles that need versatile and durable power sources. Conventional rotary engines often suffer from limitations in durability and efficiency when exposed to the marine environment's high humidity and salt concentrations. Sand and dust, commonly encountered along coasts and in the desert, can also be problematic for these engines. Recent innovations, such as the "inside-out" Wankel and rotary vane designs, have introduced new cooling and sealing concepts that could be beneficial for Naval applications, but many challenges still need to be addressed.
Current Challenges
These challenges stem primarily from the high humidity, salt exposure, and abrasive particulates. Key issues include:

- Corrosion: Saltwater and high humidity accelerate corrosion on metallic engine components. Environmental, Galvanic, Crevice, and Pitting corrosion can deteriorate the structural integrity of critical engine components.
- Abrasive Wear: Sand, dust, and salt particles enter the engine through air intakes and cooling systems, causing abrasion on critical surfaces like apex seals, rotors, and housing walls. This wear diminishes efficiency, lowers power output, and shortens component lifetimes.
- Seal Degradation: Apex and side seals experience rapid wear in marine environments, leading to reduced compression and higher oil consumption.
- Heat Management: High humidity and salt exposure can impair heat dissipation. Poor heat transfer can result in the warping of lightweight materials, such as aluminum alloys, and accelerate material fatigue.
- Lubrication Breakdown: Exposure to moisture and salt can emulsify lubricants, reducing their effectiveness. Rotary engines that rely on oil for sealing face additional maintenance and leakage concerns caused by oil degradation.
- Coating Wear: Protective coatings that defend against corrosion and wear can deteriorate more rapidly in a marine environment, reducing their effectiveness.
- Limited Understanding and Modeling Capability: Poor understanding of degradation mechanisms complicates material, coating, and design choices while increasing modeling uncertainty. Derived fatigue and life performance estimates may be inaccurate, negatively impacting reliability, readiness, and capability.

Ultimately, this SBIR topic aims to advance the state of rotary engine materials and tribology, enabling reliable use on Navy and Marine Corps UAS. Proposers should demonstrate a strong understanding of Navy/Marine Corps unique material/tribology challenges and present a viable approach to solving them. Please note that, due to time and budgetary constraints, the authors are less interested in developing completely new engine designs. Priority will be given to efforts that leverage existing engines to demonstrate proposed technology benefits.

PHASE I: Evaluate the technical challenges and feasibility of the proposed material/coating/design solution to enhance the reliability and performance of rotary engines in marine environments.

- Technical Challenges Assessment: Conduct a detailed analysis of the material and tribological challenges associated with operating the target Rotary Engine in a marine environment. Consider specific issues associated with corrosion, wear, and thermal management.
- Solution Feasibility Assessment: Identify and assess material, coating, and architectural modifications that could address the identified challenges. Consider the practicality, cost-effectiveness, and compatibility of the proposed solution(s) with the target rotary engine application.
- Initial Risk Assessments: Identify and document any technical and programmatic risks associated with the proposed solution. Develop a risk mitigation plan that outlines specific mitigation strategies that will be used to address those risks.
- Modeling and Simulation: Use modeling and simulation tools to predict the performance and durability of selected materials, coatings, and design changes under relevant Naval conditions and to quantify how the proposed solution will mitigate issues without the need for extensive physical testing in Phase I.
- Proof of Concept Testing: Conduct proof of concept tests on a small scale to demonstrate the potential effectiveness of the proposed solution. (Note: This step may involve testing of individual components or material coupons to validate initial assumptions.)
- Cost and Schedule Estimation: Develop a detailed cost and schedule estimate for a potential Phase II effort. Include anticipated development, testing, and validation activities needed to mature the technology.

Deliver a final report summarizing the findings, assessing the feasibility of the proposed solutions, identifying technical and cost risks, and recommending next steps for development in Phase II.

PHASE II: Focus on the detailed design, optimization, fabrication, and testing of the materials, coatings, and/or design modifications identified in Phase I, including:

- Detailed Solution Design and Optimization: Develop and refine designs based on Phase I findings, optimizing materials, coatings, and structural modifications to meet marine environment requirements. Include advanced modeling and iterative simulations to ensure the proposed solution addresses challenges effectively and if necessary.
- Prototype Fabrication and Integration: Fabricate prototypes of the optimized components/assemblies for testing. Ensure that the prototypes integrate selected materials, coatings, and design improvements in a manner that closely replicates final application conditions for rotary engines in marine environments.
- Testing and Characterization: Conduct rigorous testing and characterization of the prototypes under simulated marine conditions, including exposure to saltwater, humidity, sand, and representative stress/thermal loads. Perform cyclic corrosion testing, inclusive of representative temperature variations, to demonstrate solution durability under relevant operating conditions. Assess key performance metrics, such as corrosion resistance, wear rate, sealing integrity, and thermal stability, as appropriate. Testing should aim to validate the effectiveness of the solution and identify additional refinements needed to increase the durability/reliability of the proposed solution.

- Performance Evaluation and Optimization: Analyze test data to understand the performance of the proposed solution. Based on test results, optimize the design, materials, and/or coatings as needed to further enhance the durability while reducing maintenance requirements in a marine environment.
- Risk, Schedule, and Cost Updates: Reassess technical/programmatic risks and update the cost/schedule estimates based on testing outcomes and prototype performance.

Deliver a comprehensive report detailing the prototype performance, testing outcomes, solution optimizations, and updated risk/cost/schedule assessments. Recommendations for further development or scaling should also be included, along with any insights gained for potential Navy/Marine Corps/Commercial applications.

PHASE III DUAL USE APPLICATIONS: • Collaborate with Navy stakeholders, aircraft manufacturers, and/or engine original equipment manufacturers (OEMs) to further mature and integrate the technology into Navy/Marine Corps relevant platforms.

- Transition Plan Development: Develop a plan to transition the proposed technology to a relevant Navy/Marine Corps application.
- Further Technology Maturation: Further refine the technology solution in preparation for technology transition.
- Work closely with industry partners to redesign/optimize certain aspects of the technology to meet transition requirements as necessary and to understand military/commercial requirements and formulate a realistic plan to deploy the technology. Maturation efforts that increase the power density, reliability, and overall performance of rotary engines will further increase customer interest in the technology.
- Optimize the design for manufacturability and scale up production to meet customers' needs.

The proposed rotary engine materials/tribology technology may be applicable across multiple industries (e.g., automative, commercial aviation, power generation).

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KEYWORDS: Rotary Engine; Hybrid Electric; High Temperature Materials; APEX Seals; Vane Seals; High Temperature Tribology; High Temperature Wear and Lubrication; High Temperature Ionic Lubrication; Advanced Ceramics; Additive Materials; Digital Engineering; ICME; Co

N252-105 TITLE: Machine Learning Downscaling Capability for Environmental Forecasts

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Sustainment;Trusted AI and Autonomy

OBJECTIVE: Develop a capability to generate skillful, near real-time environmental forecasts (of the atmosphere, ocean, sea ice, and/or ionosphere) at a much higher spatial horizontal resolution (less than 1 km) and vertical resolution (on the order of 10 m, particularly in the atmospheric boundary layer and/or upper ocean) than current machine learning weather prediction (MLWP) techniques using downscaling or similar methodologies for tactical/local scale applications.

DESCRIPTION: While rapid and impressive progress in the development of skillful MLWP and related environmental models over the past several years has been promising for improving near real-time forecasting, missing technological capability requirements must be solved before such tools can be used operationally. Among the biggest gaps in MLWP - as well as in operational numerical weather prediction (NWP) and even climate simulations - is the disconnect between the improved predictability from large/global scale physics and observations and the lack of forecast fidelity at the local/tactical scale (less than 1-km resolution in the horizontal and high-fidelity in the vertical). Some progress can be made rapidly through the use of ML methods ameliorating the intensive computing requirements, but other progress is needed in scientific methodology to attain higher resolution forecast from lower resolution models informed by and/or consistent with physics-based principles and/or models (see references).
This SBIR topic seeks to leverage advances in ML methods, environmental prediction, and downscaling/super resolution techniques to develop new capabilities for targeted local and tactical scale short-range to medium-range forecasts. Many uses of environmental predictions (e.g., tropical cyclone wind and surge effects, electro-optical or acoustic propagation in the boundary layer, coastal winds, terrain-induced phenomena, aviation visibility, ice-edge circulations, ocean eddies, navigation through sea ice) require knowledge of small-scale features to properly calibrate the effects of a forecast. Efforts will synthesize various methodologies to take a coarse set of environmental prediction information and utilize additional data, ML methods, and modeling techniques to better inform predictions of tactical/local scale effects. A particular emphasis on validating realistic environmental structures, particularly given the lack of observational data at these scales, will be necessary.

PHASE I: Develop and compare innovative approaches for performing high-resolution (less than 1-km horizontal grid spacing and high-fidelity in the vertical) short-range to medium-range MLWP forecasts from a lower resolution set of historical data, observations, and forecast fields. Perform a technical feasibility survey of state-of-the-science methods for developing high-resolution environmental fields, such as downscaling, nesting, mesh refinement, and super resolution sharpening and upscaling. Inform the final selection(s) of methodology by the theoretical background review as well as targeted cases studies to demonstrate the strengths and weaknesses of these methods. Prepare a final report that must include a summary of strengths and weaknesses of viable approaches, a comparative analysis, and viability for operational use (such as forecast stability, bias/accuracy, and limitations). Additionally, a Phase II plan should be included.

PHASE II: Expand demonstration into an end-to-end prototype high-resolution (horizontal and vertical) MLWP forecasting capability. While initialization, coarse forecast, and post-processing components are necessary, focus will be on improving the skill and capability of the downscaling phase of the production – in particular, addressing the fidelity of components that support resolving smaller scale processes. While explicit use of high-resolution features such as topography, bathymetry, land and sea ice character, vegetation, land surface type, urban character, etc. may not be necessary, ensure that the model should properly account for the effect of these and other local scale influences. Ensure that the downscaling capability is portable and globally relocatable to arbitrary grid sizes and resolutions at any worldwide location, with the ability to scale available data and quantify potential skill as needed. Develop a workflow that includes robust methods of validation and verification and identifies strengths and weaknesses of the product compared to traditional NWP downscaling and nesting. Perform multiple demonstrations in coordination with field testing (may be required), particularly to validate local scale effects that are not easily verified given current environmental observing network coverage. Submit required Phase II deliverables to include regular reporting, participation in program reviews, technical documentation, and the end-to-end prototype software at the conclusion of the effort.

PHASE III DUAL USE APPLICATIONS: Perform operational hardening and establish utility and trust for real-time application. Craft and demonstrate dynamic analysis software tools that quickly and accurately convey software system health, error logging and debugging, and processing metadata. Develop additional evaluation metrics and diagnostics to facilitate expert forecaster guidance on using the product (and comparing to other forecast tools in workflow). Ensure that the system has a formalized methodology and data/compute needs for model training and a separate, leaner set of requirements for operational runs, and fully documented. (Note: It is essential that a version of this system is able to run skillfully in a forward/limited compute environment.) Ensure that the techniques are generalizable to apply to a variety of environmental modeling use cases such that follow-on work and commercial applications can be addressed.

Dual-use applications will include partnering with other intergovernmental meteorological agencies such as U.S. Air Force, National Oceanic and Atmospheric Administration (NOAA), and National Aeronautics and Space Administration (NASA) as well as commercialization in multiple potential markets with high-resolution decision making requirements based on forecast skill, such as transportation (short time scales) and agriculture (longer time scales).

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KEYWORDS: machine learning; artificial intelligence; ai/ml; meteorology; oceanography; forecasts; high resolution; machine learning weather prediction (MLWP); downscaling; training datasets; transfer learning; data assimilation; parameterization; high resolution

N252-106 TITLE: Innovations in Heater Technologies for Optimized Heating during Welding

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Sustainment

OBJECTIVE: Develop and demonstrate reliable preheat and post weld heat treatment technology that can consistently heat and operate at temperatures up to 1000°F in a shipyard environment and in accordance with Navy requirements.

DESCRIPTION: Preheating and post-weld heat treatment are common requirements for the fabrication of Naval platforms. Preheating is required on a variety of naval alloys including high yield (HY) steels, high strength low alloy (HSLA), mild steel, stainless steel, copper nickel, nickel copper, and aluminum. Depending on material and thickness, temperatures can vary up to 1000°F.

In the past, heater bars could be repaired but recently the devices have changed from repairable tools to a consumable product. When heater bars, power streamer cords, or control units are broken, there is no alternative process to preheat the materials. Critical units are forced to stop and wait for equipment to become free to continue the process, leading to delays throughout the entire shipbuilding process. Heater bars and power streamer cords are no longer durable or reliable, and the current products have a lifecycle that is unpredictable. Some common issues with the heater bars are electrical shorts, connector burn out, and critical failure of the heating element. If any part of the heater bar breaks, the entire unit is unusable. Other limits such as their shapes, weights, and lack of technology monitoring impede use for specific applications requiring unique methods to ensure the products are properly heated prior to or during the welding process, which increase costs. Currently no alternative preheating solutions are suited for shipbuilding environments and there is a lack of availability and innovation in the industry to meet this requirement. The current technology is antiquated with little to no advancement in recent years. Current heating methods (induction and resistance) have availability, attachment, control, and monitoring issues that negatively impact process methods and costs.

The goal of this SBIR topic is to develop and pilot an improved technology for pre- and post-steel heating for welding. The project will investigate and identify the technology needs such as temperature control and increased durability. In addition to currently using inductive and resistive heating, other technologies could be explored.

PHASE I: Explore existing and innovative heating technologies and control mechanisms to identify a solution that can meet the Navy requirements found in reference documents such as Tech Pub 278 and Tech Pub 1688 [Refs 1,2]. Demonstrate the feasibility by a breadbox demonstration. In addition to developing the heater the proposal should address reparability, and sustainability, and data monitoring capability of the heater and control unit. Prepare a Phase II plan.

PHASE II: Develop an appropriate hardware to insert the technology in a shipyard environment. Demonstrate the robustness of the technology, reparability of the heating system, and data monitoring and control capabilities of the system.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the system and control unit, if successful, to all OEMs for naval platforms including private shipyards, public shipyards, and various repair and sustainment facilities. This technology would be applicable to all naval facilities that perform welding operations in both acquisition and sustainment.

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KEYWORDS: Preheat; post-weld heat treatment; welding; temperature control; temperature monitoring; data capture; heaters

N252-107 TITLE: A Hybrid Digital Twin Framework for Modeling Machine Process Parameters for Automated Fiber Placement-based Manufacturing of Composite Structures

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Sustainment

OBJECTIVE: Develop a physics-based and artificial intelligence (AI) driven digital twin framework to tailor automated fiber placement (AFP) process to manufacture complex composite structures with improved manufacture rates and quality.

DESCRIPTION: Low-cost composite airframes are strongly demanded by DoD and commercial industries to reduce total life cycle cost through the use of integration of automation and digital manufacturing of complex composite structures. AFP has been used extensively by major aerospace industries such as Boeing and Spirit AeroSystems for the manufacturing of large-scale composite fuselage structures. However, the poor process planning and time-consuming operator-dependent manual inspection can significantly interrupt the manufacturing process and increase the manual rework rate due to the intolerable level of fabrication-induced defects. These interruptions and need for artisan intervention to maintain part quality diminish the benefits of AFP-based composite manufacturing. An increasing amount of research and technology development has been devoted to implementing a data-driven planning, in-process inspection and defects identification, and a machine learning (ML)-based defects ranking and decision-making framework on the corrective actions to improve production rates and quality. However, key technology gaps still exist including the lack of physics models for the process simulation that is driven by the interaction of moving heat source, roller compaction, and strip tension during fiber placement. Thus, the process still requires operator intervention for corrective actions.
The Navy requires an integrated Digital Twin (DT)-based system that can construct a smart AFP (S-AFP) system by using combined sensor and synthetic data to reduce or eliminate false actions. The primary goal is to demonstrate the use of the developed hybrid DT-based framework to enhance the in-process defects monitoring, process control, and rational metric for rework. The secondary goal is to use the system to improve part performance and quality. The delivery of the project will be a software tool, which is validated by producing a representative aircraft component.

PHASE I: Develop a physics-based and AI-driven DT modeling system. Establish the feasibility of the concept. Prepare a Phase II plan.

PHASE II: Build a prototype system and demonstrate it on a composite part with at least one curvature. To demonstrate the fidelity of the algorithm, use it to predict temperature of the composite part during the AFP process. After demonstrating the accuracy of the temperature prediction using collected sensor data, develop an approach towards future implementation of a closed loop to control the heating element for achieving a desired temperature profile required for the high-quality manufacturing. The Phase II effort will include the demonstration of manufacturability and mechanical performance of the part compared with traditional AFP including metrics on rework time and machine layup time as a percentage of total working time. Apply the same modeling approach to the other process parameters including compaction, speed, and tow tension to generate a combined DT model, including a synthetic environment for simulating and analyzing possible part layups and with the ability to communicate in a closed loop fashion with the smart AFP machine to adjust process parameters to improve layup quality. Analyze the effects these parameters have on process-induced defects through successive manufacturing trials. Perform the final demonstration of the effectiveness of the DT on defect reduction by manufacturing a complex panel with at least two forms of curvature. Analyze and report the same metrics used in the initial phase. Deliver a complete software that is machine agnostic and capable of being applied to a variety of AFP machines.

PHASE III DUAL USE APPLICATIONS: Support the Navy in transitioning the system to Navy use.

The expected transition targets are the original equipment manufacturers (OEMs) for aircraft.

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KEYWORDS: Composites; fabrication; AFP; Automated Fiber Placement; lightweight composites; virtual manufacturing

N252-108 TITLE: Novel Space-based Remote Sensing of Ocean Surface Vector Winds

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Space Technology;Sustainment

OBJECTIVE: Demonstrate novel capabilities to retrieve ocean surface vector winds (OSVW) and related supporting information within environmental regimes including, but not limited to, precipitation (especially in rain rates above 2 mm/hr to and in exceedance of 50 mm/hr), coastal zones, and regions with sea ice - at a horizontal resolution less than 9 km and error less than 9% - from disaggregated space based environmental monitoring (SBEM) platforms.

DESCRIPTION: Satellite remote sensing of earth's atmosphere has provided incalculable benefit to meteorological understanding and forecasting systems. As traditional large SBEM systems are becoming deprecated in favor of smaller, proliferated observing platforms, there is a growing gap to represent key air-sea interaction state variables. In particular, OSVW represents a critical environmental quantity that modulates both atmospheric and oceanic predictability. Previous work (see References) has shown the ability to derive OSVW from a variety of sensor types and algorithmic capabilities - such as via active scatterometry, passive polarimetry, and synthetic aperture radar (SAR). However, the trend for satellite system capabilities over the past decade has generally degraded OSVW retrievals due to spatial and spectral measurement compromises emphasizing other missions. This has particularly affected accuracy of OSVW in high interest areas, such as coastal zones, tropical cyclones, and around sea ice.
This SBIR topic aims to leverage cutting edge developments in Small- and Cube-Sat design, sensor capabilities, and algorithmic development that permit improved performance and lower Size, Weight, and Power (SWaP) compared to legacy observing systems. In particular, the focus of this effort is architecting and prototyping end-to-end software/algorithmic methodologies to improve the retrieval of OSVW and related quantities (such as ocean surface stress, wave and current information, etc.) under a broad variety of weather regimes and surface conditions, ultimately to demonstrating a new capability to observe atmospheric environmental variables.

PHASE I: Outline and determine the end-to-end feasibility of building and operating a small form factor space-based OSVW platform and the novel science needed to better use observed information to derive OSVW data. Detail all essential components of the remote sensor architecture as well as the infrastructure needed to collect, transmit, and process observations. Delineate the parts of the software that would be on board, versus processed after downlink from a ground station. Scope out and provide preliminary testing of an appropriate modeling and simulation (M&S) framework, including a numerical weather prediction model, surface impacts, and line element atmospheric transmittance modeling. Develop a final summary report, including literature review and overall conclusions/recommendations, to be presented at the end of this Phase. Develop a Phase II plan.

PHASE II: Produce and demonstrate a prototype software process, including the full capability to derive OSVW and related variables - potentially with a relevant sensor payload and its testing on a representative observing platform (e.g., aircraft, low earth orbit). Include a plan for a specific test validation opportunity (such as an existing planned field campaign or other data collect event) to harden development and testing timeline, as well as providing the ability to refine error and uncertainty as needed. Algorithmic development should include the framework and test cases for calibration and validation activities from raw remote sensing observations, intermediate calibrated variables, through environmental retrieval quantities. Co-location with other sources of validation, such as buoys, in-situ profilers, and/or ship or aircraft based remote sensing, will be required. Deliver a prototype software suite and a final validation report of sensor performance in a field event compared to M&S testing at the end of this Phase.

PHASE III DUAL USE APPLICATIONS: Conduct maturation efforts into a satellite analysis system: the algorithmic processing should be well aligned with the end-to-end platform integration, mission operations, communication infrastructure, and data processing chain. Commercialization efforts should be able to support/include a data service that supports meteorological data analysis, forecasting operations, and characterization for data assimilation into numerical weather prediction.

With the expansion of governmental commercial data buys (for example, by NOAA, NASA, and DoD), it is expected this project will fill critical need in the global observing system of atmospheric properties. Downstream product development for various specialized environmental applications (such as tropical cyclone intensity analysis, marine boundary layers, and ocean modeling) are also anticipated. Other civil and commercial applications, including cargo shipping and leisure cruises, will benefit from enhanced data streams and meteorological services provided from this unique observing capability.

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KEYWORDS: Ocean surface vector winds; osvw; scatterometry; geophysical model function; space-based environmental modeling; SBEM; cubesat; microwave; radar

N252-109 TITLE: Automated Intelligence Preparation of the Battlespace from Open-Source Information

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Human-Machine Interfaces;Trusted AI and Autonomy

OBJECTIVE: Develop automated tools using artificial intelligence/machine learning (AI/ML) to generate inputs to Intelligence Preparation of the Battlespace (IPB) for the Marine Corps Mission Planning Process.

DESCRIPTION: The Marine Corps Planning Process (MCPP) requires Marines to perform an IPB, which is the "systematic process of analyzing and visualizing the portions of the mission variables of the adversary, terrain, weather, and civil considerations in a specific area of interest and for a specific mission. By applying IPB, commanders gain the information necessary to selectively apply and maximize operational effectiveness at critical points in time and space." [Ref 1].

However, the IPB is a time and manpower intensive process requiring Marines to analyze physical, temporal, cognitive, and virtual considerations [Ref 2]. Open-source information is often valuable input to the IPB given the dynamic nature of many IPB considerations, but this information is frequently the costliest to find and incorporate. In a tactical situation, Marines may not have the time or expertise to perform a full analysis across these domains.

Current IPB inputs are also not easily actionable by AI/ML analytics due to the analog nature of the resulting products. Automated generation of the IPB in structured, computer-readable formats would enable additional AI/ML tools to incorporate and exploit those products in other parts of the MCPP. A tool that solve this problem should scan through open sources of information of IPB-relevant content. Open sources to include scans should be both user-provided and discovered by web scraping. It should then retrieve and parse that information into a structured, computer-readable format usable by other analytics supporting MCPP. IPB content generated by the tool should include references to the original source of the information. The tool should estimate the accuracy of the information based on the source, the correlations between different open sources, and the correlations to authoritative U.S. sources. Marines should also be able to influence rankings of specific generated content or source sites.
The focus in developing the tool should be in discovery of relevant information to the IPB process, computer understanding of that information, AI-assisted data and cleaning transformation to enable rapid, actionable use by other algorithms, and content evaluation (i.e., source quality, accuracy, uncertainty estimates) of the generated information. Previous work in this area used Natural Language Processing (NLP) and Semantic Search techniques but were lacking in both quality and specificity of the generated information. Generally, results from previous techniques still required significant human review and refinement. Recent innovations in Large Language Models (LLMs) and Deep Learning are expected to support significant improvements in the development of a solution.

PHASE I: Determine the technical feasibility of a concept for the automated generation of IPB content. Develop a quality metric for discovered data sources to include accuracy/uncertainty considerations and user preferences. Prepare a Phase II plan.

PHASE II: Develop and evaluate a prototype for the automatic generation of IPB products from open sources. The prototype should use both a pre-defined list and automatically discovered sources. The prototype should generate IPB products targeting a minimum of three IPB considerations (e.g., civil considerations, adversary order of battle, adversary tactics, etc.). Generated products should be stored in data formats optimized to the structure of the underlying information such as JSON, Geo Tag Image File Format (GeoTIFF), and Network Common Data Form (NetCDF., etc. A product quality metric should be developed as an extension of the data source quality metric. The product quality metric should granularly evaluate information found in data sources for accuracy/uncertainty via correlation with other sources (both other open sources and authoritative sources) or other means. For Phase II authoritative sources need only include trusted public sources (e.g., open access government webpages).) The prototype should support user input to refine source quality and the accuracy of specific information in the system. Produce the following deliverables: (1) a working prototype developed according to the extended Phase II requirements; (2) product quality metric methodology; (3) a test report documenting results of prototype evaluation.

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Develop the software for evaluation to determine its effectiveness in either a formal Marine Corps schoolhouse or other training setting. Incorporate the product into larger AI-enabled mission planning tools such as the Higher Echelon Mission Planner. Generated IPB products will be presented directly to the Marines via the planning tool and used as inputs to other AI/ML analytics support course of action analysis.

As appropriate, focus on broadening capabilities and commercialization plans. Development of affordable, scalable, non-proprietary technologies are needed to accelerate the transition of the Marine Corps to an information age model. The commercial sector is developing some of these AI-enabled technologies, but they often do not deal with critical issues regarding non-existent, limited, or low-quality source data, do not address the diversity of data modalities employed by Naval forces, and often come with prohibitive licensing and usage fees. This technology will have broad application in the commercial sector. Examples of businesses that would be interested in this technology include companies developing generative AI, companies providing search engines, and news media. All of these companies would benefit from the ability to identify low-quality source data to improve the accuracy of the information they provide to their customers. Additionally, companies focused on Generative AI have also been pushing to incorporate non-textual data into their offerings. Research with multi-modal data sources would benefit them as well.

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KEYWORDS: Artificial Intelligence, Machine Learning, Mission Planning, Intelligence Preparation of the Battlespace, IPB, Marine Corps Planning Process, MCPP, AI/ML

N252-110 TITLE: Modeling and Simulation for Multi-modal Exercises

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Sensing and Cyber;Sustainment

OBJECTIVE: Develop a simulation model of information warfare that can realistically simulate multi-modal information attacks, in particular cyber-attacks and their precursors in social media campaigns. This model would be used for joint live, virtual constructive exercises to more realistically engage the training audience in scenarios in which information conflict plays important roles. This model be capable of developing and improving scenarios for multi-modal information warfare and provide guidance to planners and trainers to author and manage these exercises. The capability to explain, visualize and provide white cell adjudication support is highly desired in the final product.

DESCRIPTION: Social media provides cyber-attackers with the affordances to recruit confederates in cyber-attack, track mission execution, and perform other acts of coordination prior to and during these attacks. Currently little training is available to assist cyber-defenders to identify the social media precursors, coordination efforts, and tracking. Most cyber-defense exercises are “tabletop” efforts that are largely controlled through “white card injects,” Participants are told something has happened, then they are tasked to explain how they would respond. These exercises fail to prepare the participant in the role of first responder/cyber defender to “train as they fight” – to experience the many cues and tips that precede a cyber-attack or to rehearse the steps that they would take to discover, counter, and defeat cyber-attacks. Simulation exercises are needed to provide the opportunity for cyber-defenders to experience rehearsal and response in a sandbox environment to these types of hybrid attacks. The Navy seeks a model that brings together simulations of cyber-attack with simulated social media precursors and related information flows (i.e., “social-cyber maneuvers”). This would enable exercises to include cyber-attack together with their social-cyber precursors and counter-arts for live virtual constructive training.
The desired deliverable would develop: (1) a collection of related hybrid cyber and social-cyber data indicative of these hybrid maneuvers to provide the foundation for a realistic, validated augmented generation system for scenario data; (2) a framework for information maneuvers that broadly encompass cyber and social-cyber maneuvers that would support scenario development, synthetic data production, and scenario validation (for example, the MITRE ATT&CK framework); (3) authoring tools and decision aids to guide the development of social-media facilitated cyber-attacks; and (4) a simulation model that brings together the data and the framework to enable exercise planners to develop realistic scenarios and vignettes for social media facilitated cyber-attacks. The desired deliverable would be able to produce realistic scenarios in under 1 month. It is highly desired that scenario updates and vignette changes are possible in 24 hours so that training could be changed, with the scenario “sped up” or “slowed down” based on participant performance and with injects that could be created and launched during the exercise itself.

PHASE I: Collect and validate data relevant to hybrid (cyber and social-cyber) attacks in a particular use case or set of use cases. Determine an initial data synthesis capability (such as a large language model) that can produce synthetic material indicative of an impending cyber-attack. Establish the feasibility of the initial framework for describing relationships, stages, and red flags that suggest cyber-adversaries are active. Prepare a Phase II plan.

For example, a Distributed Denial of Service (DDOS) attack has several stages: the “call to arms” stage in which audiences are enraged and encouraged to support the attack; recruitment of cyber-attackers; the distribution of tools and resources; the identification of targets and the coordination of “fires” in terms of time and targets. This is an example of an initial use case for Phase I development.

PHASE II: Enlarge the use cases from Phase I and collection of data relevant to these use cases for inclusion in a realistic augmentation generation system needed to validate synthetic data and conform to the developed framework. Develop a catalog of use cases and related information needed to guide exercise planners. Mature the Phase I data synthesis capability (possibly a special use large language model) to produce realistic volumes of synthetic data for information warfare exercises. Develop authoring tools to assist exercise planners in developing scenarios by using the framework and catalog of use cases. Create a working prototype of the simulation capability capable of a full technical demonstration in a live, virtual constructive exercise for validation of the system.

PHASE III DUAL USE APPLICATIONS: Support the transition of the simulation model to Navy use. Components of this effort would be useful to cybersecurity companies in developing simulations of cyber-attacks and their precursors for the purpose of training cybersecurity professionals.

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KEYWORDS: Training, exercise, cyber-defense; cyber-attack; information warfare; modeling and simulation

N252-111 TITLE: Dynamic Scheduler for Digital Signal Processing in Software Defined Radios

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Sensing and Cyber;Microelectronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a stable control module for a wideband receiver that adapts in real time to changing mission priorities and the signal environment. This software/firmware module will take a list of signals to be processed and schedule the proper digital signal processing algorithms onto commercial off-the-shelf (COTS) processing cards available within the same server and ensure the signal data arrives on actionable timelines.

DESCRIPTION: The Department of Defense (DoD) has historically procured progressively optimized receivers for each distinct class of radio frequency (RF) system functionality. Software Defined Radios (SDRs) have increasingly become a deployed reality and the diversity of signal definitions each transmitter is capable of emitting increases with fewer and fewer limitations. Fortunately, each class of generic hardware processor (i.e., Central Processing Unit (CPU), Graphics Processing Unit (GPU), and Field Programmable Gate Arrays (FPGA)) has also become more capable of being used for hosting multiple copies of different algorithmic techniques running simultaneously. The notion of using only multi-functional receiver systems capable of being reconfigured to function differently for different signal classes reflecting their distinct functional foci is a natural consequence of these trends.
The Navy now desires technology that enables RF system reconfiguration of functionality to be performed dynamically at unit levels in operational environments. If significantly sub-second time scales reprogramming of the processors can be achieved, adaptive and cognitive responses to even densely populated instantaneous signal environments become conceivable. However, the time taken to first optimize an initial Digital Signal Processing (DSP) task list and then to reprogram and/or reconfigure the available DSP processors for the selected set of tasks must be verifiably bounded because no computation can be performed during reconfiguration. Additionally, this reconfiguration time also adds to the processing latency and shortens the time available for cognitive response to the sensor output. Conversely, too short an interval between reprogramming events can both potentially lead to chaotic system behavior and disrupt signal analysis of complex signals mid-stream, leading to un-converged results and a sub-optimal use of processor time.

This SBIR topic solicits vendors with experience in the control of task scheduling/resource management to devise a generic parameterized scheduler for DSP processing on a diverse set of generic COTS processor cards. Innovations that reduce latency in both the optimization of the laydown of DSP techniques onto the processors and the implementation of such laydowns are desired. The topic’s goals are optimization of a scheduler for stable operation, for devoting less than 10% of real-time set-up for the next batch processing epoch, and for maximizing the total priority assigned to individual signals whose processing can be accommodated by the decided upon laydown of techniques onto the DSP processors during these epochs. This includes the general tasks of generating software/firmware coding to optimize the processing laydown; initiating the processing code laydown on the processors; coordinating the retrieval of cued In-Phase and Quadrature (I&Q) data; and ensuring timely delivery of data to the designated processor card/node. (Notice that we assume each time-frequency bounding box worth of new signal data can be associated with a specific signal class and that such cues (i.e., boxes + signal ID) can be manipulated by the scheduler without having to move the actual I&Q data from its temporary memory location until the DSP will begin.) It is also desirable for an output of the cues that will not be processed in the next epoch to be provided, along with a notation in the cue of such status. Either Vita 49.2 extension packets or Protobuf messages may be used for such cue enhancements.

Given the complexity of this topic, proposers may begin with a set of simplifying assumptions to be replaced with the more complex reality in later phases. For example, one initial assumption might be that a given signal's priority will be fixed, independent of how many instances the signal has in a given epoch and in how many epochs it has occurred. Determining the length of an epoch in terms of Vita 49.2 packet durations and execution times of the DSP techniques is one of the underlying challenges that requires careful reasoning and experimental verification. Later methods for the scheduler to learn the processing times of each DSP technique rather than requiring pre-calibration is desirable. Whether any signal is of such high priority that its processing can be continued over multiple epochs in order to be completed must also be decided. A study is needed of the consequences of failing to converge on the optimal technique laydown before beginning processing, as well as how to detect such an event.

The threshold system ingest bandwidth shall be 500 MHz and objective 4 GHz or more per channel, based on Analog to Digital Converters clocking at over 10 GHz. The intent for this topic is to develop contributions in scheduling DSP reconfigurations within an open, modular system. Use of Red Hat Linux and PCIE5 or higher is expected. Review of proposals will include evaluation of whether the proposed technologies will support explicitly open and modular systems.

The work to be performed beginning in Phase I will be considered CUI and ITAR controlled. In the event development becomes classified prior to Phase III, the facilities clearance status of the vendor's workplace and proposed workforce needs to be included in the initial proposal. All Phase I work will involve strictly unclassified waveforms and DSP techniques. The class and manufacturer of processor cards from combinations of CPUs, GPUs, and FPGAs will be left to the vendor. However, during Phase II, if awarded, there is expected to be a task designed to transition the new module's code into a less specific hardware dependent code such as VHDL. The Government will disclose other details of the expected open systems architecture (OSA) receiver as appropriate throughout the period of performance. This software/firmware module will take a list of signals to be processed and schedule the proper digital signal processing algorithms onto COTS processing cards available within the same server and ensure the signal data arrives on actionable timelines.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and ONR in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Design a concept for the scheduler's instruction set, needed inputs, and desired outputs. Conduct a preliminary design review (PDR) with the government sponsor. Describe approaches to both static and opportunistic reassignment of DSP techniques over COTS processors, then present a notional plan for doing rapid (sub-millisecond) dynamic reprogramming in an operational setting, defined in terms of the required components, with identification of technological component maturation and technical risks involved. Ensure that the technical approach addresses distinct cases of how many SOIs may be present and populated in the electromagnetic environment; for example, cases to consider include where it is not necessary to fully analyze every event of a specific signal class, when the execution time of each technique is not uniform, and how to minimize time wasted by processors being idle when the received environment is inherently sparse for a given signal class. Include a lab demonstration of the planned method on a synthetic sensor processor having one DSP processor and time varying numbers of signals with known/available DSP processing algorithms present. (Note: It is undesirable for the base demo to be limited to the case where the signal density is low enough to accommodate all the signals present. If so, this demonstration shall be extended in the option period, if exercised, to the case where not all the instances of signals present can be accommodated.) If the Phase I Option is exercised, improve upon the initial demonstration in a hardware realization. Prepare a Phase II plan.

PHASE II: Develop the design into a tangible realization and conduct a laboratory demonstration, possibly in simulation, of the desired reconfigurable DSP activity. Work to scale up the number of simultaneous DSP processes that can be stably managed of same and different sorts. Devise a scheme for dealing with waveforms that take a significantly longer time to completely process and how to optimize the system throughput and control the number of instances of a given signal to analyze out of every batch of occurrences. Expand the system to the case containing all 3 classes of mass market DSP processors and where a prioritized list of signals ready to be processed are presented to the scheduler module. (Note: This new module will then work with algorithms having different execution times and processing resource requirements.) Describe a conceptual calibration scheme. Provide an approach for an automated system to learn how much of an idle time margin must be given for maintaining stable system control. If the Phase II Option is exercised, work with the sponsor to define additional issues to address and participate in system level demos at U.S. based test events/ranges. Prepare a Phase III commercialization/transition plan.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Participate in the development of Navy RF systems utilizing the delivered products and others running simultaneously from multiple vendors, consistent with the same system architecture constraints and interface definitions. Computationally intensive applications involving big data, such as voice recognition and speech processing utilized by emerging Artificial Intelligence applications and sensor fusion required for autonomous vehicles, require complex systems controls to prevent chaotic, continual reprogramming of the DSP resources to maximize impact of processing time.

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KEYWORDS: digital signal processing; reconfigurable; Software Defined Radios; SDR; Field Programmable Gate Array; FPGA; Graphics Processing Unit; GPU; Central Processing Unit; CPU; control theory; resource scheduling

N252-112 TITLE: Generative Artificial Intelligence for Course and Content Creation and Conversion (GenAI4C)

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Human-Machine Interfaces;Trusted AI and Autonomy

OBJECTIVE: Utilize state-of-the-art artificial intelligence (AI) technologies (e.g., Large Language Models) to develop an AI-aided human-in-the-loop instructional systems design agent/coach, support conversion of "legacy" (e.g., PowerPoint and Word) course materials, and assist in generation of content within Marine Corps learning ecosystem (i.e., Moodle) to update/revise or develop new courses.

DESCRIPTION: In January 2023, the Marine Corps released "Training and Education 2030" that begins with the statement "The current [Training & Education] T&E system is not preparing the Marine Corps for the future operating environment." [Ref 1]. Today's training is built on an industrial-era model where students move through a one-size-fits-all production line, progressing through standardized programs of instruction (POIs) comprised of static slides, student handout documents, written exams, and minimal experiential learning. The same report then goes on to state that "better technology integration in our classrooms and courseware can increase production, produce a more highly trained Marine, reduce their overall time-to-train, and limit the burden on our learning infrastructure."

The recent advancement of AI technologies including Large Language Models (LLMs) and image generators such as Stable Diffusion provide an opportunity to aid Marine Corps transition from industrial to information age learning in three ways: (1) instructional systems design assistance (e.g., develop course outlines, map Knowledge, Skills, and Abilities [KSAs] to tests and quizzes, advise personnel on how to best build instructional exercises in their eLearning environment, etc.) to aid course designers, instructors, and others in revising and bootstrapping course outlines and course content to reduce challenges for personnel (e.g., intimidated by the "blank slate" of creating content from scratch); (2) content generation assistance for creation of multimedia and/or interactive learning aids that includes animations and videos, but also goes beyond the creation of quizzes and flashcards that are possible with today's LLM technologies to generate branching scenarios, and other more interactive content; and (3) conversion to bring "legacy" content (e.g., text, slides, images, infographics, complex diagrams, etc.) into the modern learning environment.

The overarching goal of this SBIR topic is not to use AI as a standalone replacement for curriculum developers, POI managers, or instructors, but to enable human-AI teams to develop and manage training for the Marine Corps faster and more effectively than current processes. Technology created from this effort is expected to show efficiency gains in content creation and course generation without negatively impacting learning outcomes. Proposed solutions must go beyond the existing commercial and open-source efforts to integrate AI into learning platforms [see Ref 2 as an example]. Proposed solutions must create desired modern, interactive-content AI models that can accept input from a variety of sources and formats and output not just text, but images, movies, and more that must work together seamlessly.

The end state of this effort is to provide a government-owned suite of AI-enabled software capabilities for use by the Marine Corps Training and Education enterprise to more efficiently and effectively create courses and content as part of modern e-learning systems that reflects a cutting-edge, information-age learning enterprise. A good example are Marine Corps maintenance schoolhouses whose courses currently include a long classroom component (e.g., PowerPoint slides and lecture) with some hands-on practical application time (e.g., performing the maintenance task on a physical system). The desire is for the classroom components to be richer with multimedia and interactive components (e.g., branching scenarios allowing students to interactively troubleshoot issues); however, creating these from scratch or

converting static text or images is time consuming. Additionally, even converting a Program of Instruction into a new, blank Moodle course is daunting.
The end goal is a tool that helps personnel take their current POI, slides, and documents and creates a new course and populates it with content. Personnel will always be in the loop to verify, modify, and add to AI-created content, but AI technologies that can bootstrap the course and content creation and conversion process would be a significant savings of time and effort.

Due to the potential long review times involved, human subject research is discouraged during Phase I. Phase II plans should include key component technological milestones and plans for at least one operational test and evaluation, to include user testing.

PHASE I: Develop early concepts, wireframes, workflows, and requirements for AI-enabled modern training and education software capabilities to include support for instructional systems design processes (e.g., creating course outlines in eLearning systems based off a Marine Corps POI), content (i.e., multimedia and interactive) creation, and “legacy” (i.e., static PowerPoint and Word) content conversion. Show how the human-AI team will work together to produce training content, since the human designer is an essential part of the development process.

Human factor and human subject testing are critical in follow-on Phases of this topic. Please carefully review the requirements of approval for proposals that include testing of human subject and compliance with Institutional Review Board (IRB) [Refs 3, 4].

PHASE II: Conduct an evaluation with Marines (coordination aided by ONR) of AI-enabled capabilities outlined during the Phase I evaluation to include a usability assessment, process improvement demonstration, and effectiveness evaluations where appropriate. Perform additional demonstrations/experimentation that show system extensibility through plug-and-play of new and updated AI models to improve and expand upon overall system capability. Collect impressions of usability and develop objective metrics of time and effort to create and convert courses and content with a relevant Marine Corps population (i.e., including Marine Corps government and civilians in-the-loop of the course and content creation process). Perform all appropriate engineering tests and reviews, including a critical design review to finalize the system design.

Produce the following deliverables: (1) a working prototype of the system that can interact with existing system specifications; (2) evaluation of system usability and efficiency to convert and create content and courses; (3) a system effectiveness evaluation of system capabilities to provide demonstrable improvements (Human Subjects protocol needs to be approved in Phase II Option if needed for this evaluation).

PHASE III DUAL USE APPLICATIONS: Support the Marine Corps in transitioning the technology for Marine Corps use. Develop the software for evaluation to determine its effectiveness in either a formal Marine Corps schoolhouse or other training setting. As appropriate, focus on broadening capabilities and commercialization plans. Development of affordable, scalable, non-proprietary technologies are needed to accelerate the transition of the Marine Corps to an information age training model.

The commercial sector is developing some of these AI-enabled T&E technologies, but they often do not deal with critical issues regarding non-existent, limited, or low-quality source data, do not address encryption and classification requirements, and often come with prohibitive licensing and usage fees. This technology will have broad application in the commercial sector. Specific examples of businesses in the commercial sector include Moodle (which has a commercial learning services component) and Docebo (an online learning platform for enterprises).

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KEYWORDS: Artificial intelligence; machine learning; AI/ML; content creation; training and education; instructional systems design; large language models

N252-113 TITLE: On-Chip Modulator for Cryogenic Electro-Optic (EO/IR) Sensors

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Integrated Sensing and Cyber;Microelectronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop and demonstrate a novel photonic integrated circuit (PIC)-compatible optical modulator for on-chip integration with cryogenically cooled electro-optical and infrared (EO/IR) sensors.

DESCRIPTION: Emerging military EO/IR sensors are being developed with smaller pixels and larger array sizes to enable high spatial sampling (i.e., pixel pitch and frame size), high temporal sampling (i.e., frame rate), low latency, and greater bit-depth resolution for real time imaging. The data bandwidth required to enable such real-time imaging for the most advanced sensor designs is reaching the limits of conventional copper wire interconnects. Datalinks using optical interconnects offer a unique and commercially mature component solution that can obviate the copper bandwidth limitation, while offering additional advantages of lower power, lower cost, and on-chip integration [Refs 1,2]. However, mature PIC-compatible modulators may not perform well at cryogenic temperatures or lack full characterization at low temperatures. Common methods used for modulation in the photonic domain include thermo-optic and electro-optic mechanisms, but these were largely developed for room temperature telecommunications applications. For example, common disk and ring resonators are very sensitive to temperature variations. Stabilization is achieved using high-speed heating elements located along the resonator surface, which increase power dissipation, introduce jitter noise, and degrade in performance at low temperature, increasing bit error rate (BER) and reducing modulation bandwidth significantly. Moreover, large bandwidth bottlenecks can be imposed by the integration strategy, such as wire-bonding, whereas flip-chip or alternative integration schemes could offer better performance.

Recently, an electro-absorption-based modulator (EAM) demonstrated > 30 Gbps bandwidth at cryogenic temperatures, which was limited by wire-bond integration, but eliminated the need to maintain resonant coupling [Ref 3]. The EAM is based on the Franz-Keldysh effect, which can provide a constant extinction ratio from room temperature down to 5K. Thin-film lithium niobate (TFLN) modulators, alternatives based on the Pockel's effect, are also candidates for PIC-compatible cryogenic modulators, becoming more efficient at low temperatures and being compatible with Si foundry processing lines. While these advances are promising, innovations in cryo-compatible modulator design and integration are needed to increase modulation bandwidth, improve operational stability, and to facilitate automated operation. The goal of this SBIR topic is to develop or advance a PIC-compatible optical modulator that can stably operate within the relevant cryogenic temperature range for EO-IR sensors (~77K-120K) and can enable on-chip integration with EO/IR sensors.

PHASE I: Design a concept for a PIC-compatible photonic modulator that can provide stable high-speed modulation and tuning at cryogenic temperatures to enable high bandwidth readouts for EO/IR sensors. Establish proof of concept. Develop a modulator fabrication process and a modulator test plan for Phase II.

PHASE II: Optimize electrical and optical design and fabricate a packaged modulator prototype. Demonstrate modulator electrical and optical performance for high speed, high frequency range, and high bandwidth cryogenic operation (77K-120K). Demonstrate single-mode fiber pigtailed electro-optic modulator packaging. Prepare a Phase III commercialization/transition plan.

PHASE III DUAL USE APPLICATIONS: Transition the demonstrated modulator technology to EO/IR sensor systems onto Naval Surface and Expeditionary Platforms.
Cryogenic PIC-based modulators can also be applied to quantum sensing/computing, free space optical communication, and electromagnetic warfare (EW) applications.

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3. Chansky, E. et al., "High-Speed SiGe EAMs at Cryogenic Temperatures." 2022 IEEE Photonics Conference (IPC), Vancouver, BC, Canada, 2022, pp. 1-2. doi: 10.1109/IPC53466.2022.9975738

KEYWORDS: Optical Modulator, Cryogenic, Electro-Optic Sensors; EO/IR

N252-114 TITLE: Logistic Modeling and Simulation for Hypersonics

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Hypersonics;Integrated Network Systems-of-Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a Modeling and Simulation (M&S) tool that is capable of capturing timing windows for different phases of the weapon system's operational lifecycle based on system, subsystem, and component requirements, weapon system Concept of Operations (CONOPS), and dependencies on external systems or institutions. This tool must be able to determine the minimum and maximum allowable times for certain events based on relevant factors including but not limited to heating rates and receipt of critical mission data during operational use.

DESCRIPTION: The M&S tool will need to consider combinations of various physical effects during pre-launch, launch, and post-launch that affect the integrity and health of the weapon system and finds points of failure. For the pre-launch phase, the tool will need to predict the overall internal temperature of the system due to excess heat generated by onboard electronics, determine possible launch windows that fit within the constraints of onboard systems and/or external environmental conditions, and vibrations during deployment but prior to launch. For the launch phase, the tool will need to predict the overall impact of shocks, vibrations, and accelerations on components during launch. For the post-launch phase, the tool will need to track heating rates from external aerodynamics and internal electronics, Concepts of Operations (CONOPS)- driven vehicle reorientations, required operating windows for onboard systems, externally received signals, and computation time to react to new commands during flight. The tool will also need to calculate timing to inform logistics analysis, like mean time between failures (MTBF) for technologies affected by the conditions described for each phase. This tool will be used by integration experts, logistics assessment experts, and mission planning. This will aid in the confidence of the logistic assessment, storage, transportation, and technology requirements. This M&S capability must be able to modularly accept reference information generated by high fidelity physical models, such as equations, look-up tables, or state information. This project will transition to defense contractors for high-speed weapons and space systems. To meet these needs, maturation and packaging of the technology to meet practical size, weight, and power constraints will be required. Extreme environments may require special considerations to conform to airframe shape and shielding from the aerothermal environment.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program

Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Provide a concept for a logistics M&S capability that can capture timing windows for different phases of a weapon system's operational lifecycle based on system. Ensure that the concept addresses the generation of timing predictions for the pre-launch and post-launch phases using approximations of relevant environmental information or operational constraints of systems. Include heating information that can be represented by polynomial functions over time, piecewise or not, or as tabular lookups. Develop heating models that consider sub 300 degrees Celsius (°C) for the pre-launch phase and greater than 1,000°C for the post-launch phase. Demonstrate models of various conditions that may be present pre-launch, during launch, and post-launch. Provide computational calculation times that can be represented by simple equations to determine how long different phases of calculation last, capturing time to receive and process a command, recalculate, and deploy the command with respect to the remaining time in the mission. If the Phase I Option is exercised, include the initial design specifications and capabilities description to build a prototype solution in Phase II. Prepare a Phase II plan.

PHASE II: The Phase II effort will require the ability to perform work in a classified environment. Concepts presented in Phase I will need to work with classified reference values. Develop a prototype M&S tool that can generate parametrically based on mission parameters. Apply and further develop the prototype for specific cases prioritized by the Conventional Prompt Strike (CPS) program and begin using program data.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: If the demonstration in Phase II is deemed to be of high interest to the Government, support the Government in transitioning the technology for Government use to support current and future weapon and space systems, as well as a wide range of other air-, land-, and sea-based systems.
Commercial applications should be considered for transition (i.e., 5G, navigation systems, and tracking systems).

REFERENCES:

1. Kasim, B; Çavdar, A.B.; Nacar, M.A. and Çayirci, E. "Modeling and Simulation as a Service for joint military space operations simulation." The Journal of Defense Modeling and Simulation, 18(1), 2021, pp. 29-38. doi:10.1177/1548512919882499
2. Kemp, Jesse A."Modeling and simulation in support of operational test and evaluation for the Advanced Amphibious Assault Vehicle (AAAV)." Naval Postgraduate School, Monterey California Dissertation, 2001. https://core.ac.uk/download/pdf/36703284.pdf

KEYWORDS: Logistics; Modeling; Simulation; Mean Time Between Failure: Integration; Lifecycle; Root Cause Analysis; Risk; System Configuration; System Engineering; Model Based System Engineering

N252-115 TITLE: Low Size, Weight, and Power (SWaP) Phased Array For Vehicle Tracking Using Signals of Opportunity

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Hypersonics;Integrated Network Systems-of-Systems;Microelectronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a state of the art (SOTA) low size, weight, and power (SWaP) phased array capable of increasing positional accuracy of a vehicle in a hypersonic regime using signals of opportunity.

DESCRIPTION: Phased Array Tracking is currently being used for fifth generation (5G) cell towers. The tracking is done with stationary active electronically scanned arrays (AESAs) and targets slow moving people or networks to send information. The Conventional Prompt Strike (CPS) Program would like to use a passive phased array that tracks signals of opportunity (SoOp) to give real-time position updates/corrections to a hypersonic vehicle. Given a known position of a radiating system, the phased array can track the angle of arrival (AoA) of a radiated signal. With the AoA and known position of the stationary system, the position of the vehicle can be estimated. This allows corrections to the inertial measurement unit’s (IMU’s) drift error. The phased array may use any low earth orbit (LEO), GPS, or stationary high power SoOp. The trade space between range and size of the phased array is a significant consideration for design. This project will transition to defense contractors for high-speed weapons and space systems. To meet these needs, maturation and packaging of the technology to meet practical size, weight, and power constraints will be required. Extreme environments may require special considerations to conform to airframe shape and shielding from the aerothermal environment.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Conduct a feasibility study to show the use of a passive phased array to track a SoOp and give real-time estimations for the hypersonic vehicle’s position. The technology shall show improvements in positional accuracy with varying distance and incident angles from the SoOp, resistance to power saturation of noisy environment, while minimizing SWaP. The use of modeling and simulations is recommended with limitations on budget for hardware in Phase I. Technical merit and competence is evaluated based on the use of models and simulations, algorithms, and technical plan of action. The Phase

I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Demonstrate software and algorithms with the use of the passive phased array to locate a vehicle's current position with the use of the SoOp as an external reference point addressed in the Phase I. The Phase II Statement of Work (SOW) should identify a work plan that provides proof of concept that the technology has the potential to meet the military performance goals, highlighted in Phase I. Work should focus on the increase in accuracy consistency, and reliability. A prototype, modeling and simulation, and/or software shall be provided with intent to be integrated into test assest(s) for verification and validation of the technology by the end of the Phase II.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: If the demonstration in Phase II is deemed to be of high interest to the Government, support the Government in transitioning the technology for Government use. The transitioned product is expected to be able to support current and future weapon and space systems, as well as a wide range of other air, land, and sea-based systems.
Commercial applications should be considered for transition (i.e., 5G, navigation systems, and tracking systems).

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1. Wei, Teng and Zhang, Xinyu. "mtrack: High-precision passive tracking using millimeter wave radios." Proceedings of the 21st Annual International Conference on Mobile Computing and Networking, 2015. https://xyzhang.ucsd.edu/papers/TWei_MobiCom15_mTrack.pdf
2. Karanam, C. R.; Korany, B. and Mostofi, Y. "Magnitude-Based Angle-of-Arrival Estimation, Localization, and Target Tracking."17th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN), Porto, Portugal, 2018, pp. 254-265, doi: 10.1109/IPSN.2018.00053
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KEYWORDS: Phased Array; Passive; Angle of Arrival; Radio Frequency; Radiation; Signals of Opportunity; Hypersonic; Tracking; Fast Tracking; Low Latency; Algorithm; Tracking Algorithm; Passive Electronically Scanned Array; Active Electronically Scanned Array; Signal

N252-116 TITLE: Delay and Denial of Unmanned Underwater Vehicles

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Network Systems-of-Systems;Trusted AI and Autonomy

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an innovative solution to delay trespassers or deny access to naval assets by Unmanned Underwater Vehicles (UUVs), Autonomous Underwater Vehicles (AUVs), and Remotely Operated Vehicles (ROVs).

DESCRIPTION: The proliferation of UUVs has created a need for the U.S. Navy to increase its ability to delay trespassers and deny access to its assets. Permanent underwater barriers are not considered a viable option due to the interference with our own port operations. Therefore, a more operationally supportable approach is required to achieve the U.S. Navy's aims. The Navy is searching for the capability to block, capture, redirect, destroy, or in any other manner neutralize the threat of an unauthorized UUV that is trespassing into sensitive underwater areas.

The innovative solution will be capable of delaying and denying small and medium sized UUVs travelling at sprint speeds [Ref 2]. The U.S. Navy defines small and medium UUVs as having a diameter no greater than 21 inches. The solution will be capable of or denying these UUV classes at depths up to 800 feet below the surface. Once the solution is deployed, it will allow the UUV to travel no more than 200 m, and ideally no more than 100 m, before being rendered ineffective.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Define and develop a method to deny an UUV access to our assets once it has been identified that meets the requirements in the Description. Define the proposed components of the system, including power sources, electronics, denial tactics, interfaces, and any other design components deemed necessary by the developer. Demonstrate the feasibility of the concept through modelling and simulation.
The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype UUV Delay and Denial system that meets the requirements listed in the Description. Demonstrate the efficacy of the system in an appropriate environment. The prototype shall be delivered by the end of Phase II.

It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the U.S. Navy while transitioning the technology to Navy use through production, integration, and maintenance. Ensure that the final product includes any systems required for interception and subsequent denial or destruction of unauthorized UUVs. A user-friendly interface for ease of use should also be part of the final product.
Prepare a strategy to utilize the technology for commercial use. Possible uses include protection of commercial ports and shipping, or research into marine life.

REFERENCES:

1. Pullen, John. “The Latest Advancements in UAS.” Avionics International, May 2023. https://www.aviationtoday.com/2023/05/04/the-latest-advancements-in-uas/
2. “What is the Best Underwater Drone?” Flying Magazine, May 2024. https://www.flyingmag.com/guides/best-underwater-drone/

KEYWORDS: Delay; Deny; Interdiction; Unmanned; Autonomous; Harbor Protection; Capture; Three Dimension Trajectory; UUV; AUV; Underwater Vehicle

N252-117 TITLE: Interception of Unmanned Underwater Vehicles

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Network Systems-of-Systems;Trusted AI and Autonomy

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an innovative solution to intercept Unmanned Underwater Vehicles (UUVs), Autonomous Underwater Vehicles (AUVs), and Remotely Operated Vehicles (ROVs).

DESCRIPTION: UUVs are a rapidly advancing technology, with their future progression likely following a similar path to that of Un-crewed Aerial Systems (UASs). Over the past decade, UAVs have significantly improved in navigation and maneuverability, and nations around the world have supported these developments for their own purposes [Ref 1]. Events in recent global conflicts indicate that similar technological advances are well on their way for UUVs. Therefore, an ideal proposal for UUV systems should allow flexibility for future enhancements, particularly the potential to improve the system's capabilities to intercept future threats.

The proliferation of UUVs has created a need for the U.S. Navy to increase its ability to prevent trespassers from accessing its assets. Permanent underwater barriers are not considered a viable option due to the interference with our own port operations. Therefore, a more operationally supportable approach is required to achieve the U.S. Navy's aims. The Navy is searching for the capability to intercept any unauthorized UUV that is trespassing in sensitive underwater areas. Interception is defined as the capability to reach the location of a trespassing UUV with enough accuracy for neutralizing actions to take place.

The innovative solution will be capable of intercepting small and medium sized UUVs travelling at sprint speeds [Ref 2]. The U.S. Navy defines small and medium UUVs as having a diameter no greater than 21 inches. The solution will include the capability to intercept these UUV classes at depths up to 800 feet below the surface.

Modelling the interception of underwater vehicles has additional challenges. UUVs operate in three-dimensional (3D) space, increasing the number of possible trajectories they can take. An interceptor can commit to an intercept path, but if the unauthorized UUV changes its trajectory, the higher density fluid (in contrast with air) means that it will take longer for the interceptor to fully react to the change. If the UUV is faster than the interceptor, the problem is compounded. Furthermore, the additional trajectories allowed in 3D space also limit the interceptor's ability to fully anticipate and prepare for changes in the UUV's motion [Ref 3].

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PHASE I: Define and develop an interception method that meets the requirements in the Description. Define and develop a method to deny the UUV access to our assets once it has been intercepted and meets the requirements in the Description. Define the proposed components of the system, including power sources, electronics, interception algorithms, denial tactics, interfaces, and any other design components deemed necessary by the developer. Demonstrate the feasibility of the concept through modelling and simulation.

The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype UUV Interception and Denial system that meets the requirements listed in the Description. Demonstrate the efficacy of the system in an appropriate location. The prototype shall be delivered by the end of Phase II.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the U.S. Navy while transitioning the technology to Navy use through production, integration, and maintenance. Ensure that the final product includes any systems required for interception and subsequent denial or destruction of unauthorized UUVs. A user-friendly interface for ease of use should also be part of the final product.
Prepare a strategy to utilize the technology it has developed for commercial use. Possible uses include protection of commercial ports and shipping, or research into marine life.

REFERENCES:

1. Pullen, John. “The Latest Advancements in UAS.” Avionics International, May 2023. https://www.aviationtoday.com/2023/05/04/the-latest-advancements-in-uas/
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KEYWORDS: Interception; Interdiction; Unmanned; Autonomous; Harbor Protection; Capture; Three Dimension Trajectory; UUV; AUV; Underwater Vehicle

N252-118 TITLE: High Sensitivity Piezo-Ceramic Materials for Hydrophone Devices

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Integrated Sensing and Cyber

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Demonstrate improved piezo-ceramic materials and hydrophone devices with at least 6 dB gain in sensitivity over existing solutions for Navigational Sonar Systems (NSS) applications.

DESCRIPTION: Piezo-ceramic materials provide the heart of nearly all Navy acoustic transmit and receive systems. There are a wide range of transmit materials available for system designers to choose from. However, for passive receive applications, the number of materials available to design around are limited to 2-3 choices. This technology space has not evolved in 20 years and thus sensor design has also stagnated. With the development of textured ceramic processing technology, new possibilities exist for creating enhanced hydrophone materials [Ref 1]. This could offer system designers more freedom in terms of size reduction, shape, configuration, enhanced signal to noise ratio, and a wider supplier base for material procurement.

Prior Navy investments in textured ceramics have focused heavily on materials for transmit applications [Ref 2]. As such, this technology space is maturing rapidly. This SBIR topic seeks to leverage these previous investments and provide new materials for receive-only applications. Specifically materials and manufacturing methods designed to deliver piezoelectric voltage coefficients, g33, g31, and g15, of at least 100 V·m/Nx10-3, 35 V·m/Nx10-3, or 75 V·m/Nx10-3 respectively, with a dielectric constant of at least 500 (unitless) and a dielectric loss tangent of < 0.005 (unitless) (all at 1V drive, 1 kHz frequency) are targeted, as are advanced manufacturing techniques [Refs 2,3,4]. These g-coefficient values represent a 2x increase over the best available materials and are expected to yield the desired minimum improvement in hydrophone sensitivity over a wide range of possible sensor designs. The targeted dielectric constant and loss tangent values are mandated by the need to maintain signal to noise ratio (SNR) performance [Ref 5].

PHASE I: Conduct an initial study of the required material properties of highly sensitive piezo-ceramic materials to include the following items:

- A discussion of how the technology approach will satisfy the advanced material properties requirements. This could include traditional ceramic processing, tape casting, additive manufacturing, or other techniques.
- A discussion of the material chemistry and fabrication processes required to achieve the desired properties including an assessment of risks and risk mitigation strategies.
- Ability to scale processing to part quantities of 1000 should be discussed along with a projected process rate.
- Initial demonstrations of material properties showing feasibility of achieving the desired properties.
- A discussion regarding the material’s impact to receive device applications.

- Device modeling and simulation (based on available material properties) to demonstrate free field voltage sensitivity or acceleration sensitivity at frequencies from 1 to 100kHz, although it is not necessary to cover the entire band.

The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build prototypes solution in Phase II.

PHASE II: Produce prototype materials in sizes and shapes allowing for prototypes of relevant Navy sensors to be constructed. Produce and demonstrate on representative test pieces, with the accompanying full matrix of piezoelectric coefficients required for accurate simulation of sensor devices per ANSI/IEEE STD 176-1987 [Ref 6]. Demonstrate new device concepts possible with enhanced material properties at the prototype level. Provide advanced characterization of the materials and devices, including property variation with pre-load stress, property variation with temperature, and material microstructure. Deliver three (3) prototype devices for testing as well as the modeling and simulations for further integration including simulated free field voltage sensitivity (FFVS) and beam patterns for devices over the frequency range of 1 to 100 kHz. These simulations should include an assessment of survival of grade A and grade B underwater explosive shock per MIL-S-901D [Ref 7] with recommendations on how to improve the design for shock tolerance. The prototypes shall be delivered by the end of Phase II.

PHASE III DUAL USE APPLICATIONS: Based on the prototypes developed in Phase II, continue development that must lead to productionization and demonstration of an array of hydrophones leading toward integration within existing submarine housings. Address minimizing lot unit variability. These arrays should be characterized for FFVS and beam patterns. In addition, the arrays should be characterized for survival of grade A and grade B underwater explosive shock per MIL-S-901D test conditions and procedures.

In addition to military application, these hydrophones are applicable for other commercial maritime applications. These areas include commercial shipping vehicles, underwater unmanned vehicles (UUV), and submarines.

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KEYWORDS: Piezoelectric voltage coefficient; Textured ceramic; Piezoceramic; Hydrophone; Sensor; Ceramic processing

N252-119 TITLE: Novel Detection Methods for Unmanned Underwater Vehicle

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Integrated Network Systems-of-Systems;Trusted AI and Autonomy

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop an innovative solution beyond the traditional active and passive sonar technologies to detect Unmanned Underwater Vehicles (UUVs), Autonomous Underwater Vehicles (AUVs), and Remotely Operated Vehicles (ROVs).

DESCRIPTION: UUVs are a rapidly advancing technology, with their future progression likely following a similar path to that of Unmanned Aerial Vehicles (UAVs). Over the past decade, UAVs have significantly improved in navigation and maneuverability, and nations around the world have supported these developments for their own purposes [Ref 1]. Events in recent global conflicts indicate that similar technological advances are well on their way for UUVs. Therefore, an ideal solution should allow flexibility for future enhancements, particularly in detecting emerging threats.

The proliferation of UUVs has increased the need for the U.S. Navy to have the capability to detect unauthorized entry into controlled areas. Traditional sonar systems are well-established. Active sonar systems have proven to be our most effective means of locating objects underwater, since they generate their own sound waves and energy source. However, this same wave generation can disclose their position to an observer, and they have been less effective against the smaller vehicles that have proliferated in recent years. Furthermore, active sonar can be very disruptive to marine life when emitting high levels of energy [Ref 2]. Passive sonar systems do not generate their own waves, which keeps their location hidden, but also makes them reliant on an unknown object being noisy enough to stand out from the background. Essentially, passive sonar systems do not emit any sound themselves; instead they listen to the sounds naturally present in the environment.

Alternatives to sonar technologies remain in their infancy. Numerous options have been proposed to improve current capabilities, including co-opting sounds from marine life, high-quality imaging and identification algorithms, and magnetic field sensors [Refs 3,4,5]. Despite their potential, none has yet proved capable of improving our detection capabilities. The U.S. Navy wishes to further investigate the use of novel underwater detection technologies (which may or may not include the aforementioned) for the purpose of protecting its assets.

Proposals for this SBIR topic should present technologies that incorporate principles beyond those of active and passive sonar systems. The innovative solution will be capable of detecting small and medium sized UUVs travelling at sprint speeds. The U.S. Navy defines small and medium UUVs as having a diameter no greater than 21 inches. The system will be capable of detecting these UUV classes up to at least 500, and ideally 1000, yards away. It will also be capable of detecting them at depths up to 800 feet below the surface.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Define and develop a concept that will utilizes a technology that has UUV detection capabilities beyond active or passive sonar systems and meets the requirements in the Description. It. Demonstrate the feasibility of the concept through simulation and modelling. Define the proposed components of the system, including power sources, electronics, detection methods, interfaces, and any other design components deemed necessary by the developer.
The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop and deliver a prototype UUV detection system. Demonstrate, in an appropriate environment, that the prototype system meets the requirements listed in the Description. The prototype shall be delivered by the end of Phase II.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the U.S. Navy in transitioning the technology to Navy use through production, integration, and maintenance. The final product should include any systems required for detection of unknown underwater vehicles. A user-friendly interface for ease of use should also be part of the final product.
Prepare a strategy to utilize the technology it has developed for commercial use. Possible uses include monitoring of commercial ports and shipping lanes, the oil and gas industries, or research into marine life.

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KEYWORDS: Reduction of Sonic Impact; Underwater Detection; Unmanned Underwater Vehicle; UUV; Autonomous Underwater Vehicle; AUV; Diver; Sonar Alternatives; Underwater Imaging; Marine Life Sounds; Magnetic Field Sensors

N252-120 TITLE: Plasma Modeling and Simulation for Hypersonics

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Computing and Software;Hypersonics;Integrated Network Systems-of-Systems

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a plasma modeling and simulation (M&S) tool able to characterize different atmospheric conditions in a hypersonic regime. Evaluate environmental as well as electromagnetic effects such as ablation, transmissions, absorptions, reflections, and other plasma characteristics for the hypersonic vehicle.

DESCRIPTION: Plasma has unique characteristics that in some cases act as a Faraday cage, transparent medium, and/or an absorbent medium. These extremely complex characteristics cause the evaluation and assessment of plasma and electromagnetic interactions difficult to predict. M&S provides high fidelity approximations before full-scale tests. This M&S tool shall be capable of estimating the plasma characteristics based on hypersonic flight creating the plasma via velocity, altitude, species of atmosphere, density of air, material of exterior of hypersonic vehicle, solar radiation, other electromagnetic radiation, etc. Another aspect of the tool shall allow for electromagnetic interactions with the plasma and the effects of the interaction on both the plasma and electromagnetic waves. This includes showing ablation, thermal, and other effects on the surface of any material that could be on the vehicle. The plasma expands as atmospheric pressure changes. This change in plasma density and plasma volume has various effects that may also be modeled. This tool must be user friendly for electromagnetic evaluation for those with limited plasma physics knowledge, such as engineers. This project will transition to defense contractors for high-speed weapons and space systems. To meet these needs, maturation and packaging of the technology to meet practical size, weight, and power constraints will be required. Extreme environments may require special considerations to conform to airframe shape and shielding from the aerothermal environment.

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Demonstrate that a model can be constructed that shows the typical shape and spatial form of the plasma sheath. Show that the effects of electromagnetics with the plasma and how the plasma should change. Show a plan to calculate the effects of interactions. Demonstrate how these calculations will be processed in a low fidelity but high-speed scenario as well as in the high fidelity process. Demonstrate the M&S tool with a fundamental physics based model. Show quantitative ways to perform the model at high fidelity and with the least amount of processing time. Describe/show a user interface that those familiar with plasma physics may use to perform complex high fidelity physics based models and visualize the data efficiently as well as how less familiar users may utilize the tool. Show the plan for the tool being capable of modeling various changes to the plasma with transient responses as the vehicle travels. Show the planned ability to get still shots of the plasma and run various test cases on the still shot of the plasma. The Phase I Option, if exercised, will include the initial design specifications and capabilities description to build a prototype solution in Phase II.

PHASE II: Develop a more refined model with complex fluid dynamics and higher fidelity advanced physical models of the plasma. This will include the complexities of the electromagnetic interaction and changes in the plasma shape/form as the additional energy is added to the plasma medium. Develop the user interface to incorporate all the features described in the Phase I section . Demonstrate the high fidelity model and all the ways to assess the characteristics of the plasma in space, time, reflections, absorptions, transmission, radiation, species, etc. Deliver the tool to the Government by end of the Phase II or the Phase II Option if exercised.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: Support the Government in transitioning the technology for Government use. Ensure that the transitioned product is able to support current and future weapon and space systems, as well as a wide range of other air-, land-, and sea-based systems.
Commercial applications should be considered for transition (i.e., 5G, navigation systems, and tracking systems).

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KEYWORDS: Plasma; Plasmonics; Modeling; Simulation; Hypersonic; Complex Fluid Dynamics; Low Latency; Electromagnetics; Radio Frequencies; Reflection; Absorption; Transmission; Filamentation; Arc Jet; Arcjet

N252-121 TITLE: Green Chemistry Application for Scalable Production of Carbon-Based Advanced Textiles Supporting Hypersonics

OUSD (R&E) CRITICAL TECHNOLOGY AREA(S): Advanced Materials;Hypersonics;Sustainment

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), 22 CFR Parts 120-130, which controls the export and import of defense-related material and services, including export of sensitive technical data, or the Export Administration Regulation (EAR), 15 CFR Parts 730-774, which controls dual use items. Offerors must disclose any proposed use of foreign nationals (FNs), their country(ies) of origin, the type of visa or work permit possessed, and the statement of work (SOW) tasks intended for accomplishment by the FN(s) in accordance with the Announcement. Offerors are advised foreign nationals proposed to perform on this topic may be restricted due to the technical data under US Export Control Laws.

OBJECTIVE: Develop a processing method using green chemistry to produce carbon fiber from advanced organic textiles for hypersonic applications. Provide sustainable alternatives to commonly used chemicals or processes by reducing solvent byproducts, hazardous chemical use, and increasing yield that address long-term affordability.

DESCRIPTION: The advent for advancements in Hypersonics has been upon us for the last two decades. Matching the performance metric of continually going faster with each new design iteration, the Thermal Protection System (TPS) plays a major role in a hypersonic flight vehicle's (HFV) performance at high MACH numbers. The TPS operates to protect the substructure of the HFV from high temperature aerodynamic heating. The majority of the TPS structure is composed of carbon fiber, derived from textiles such as polyacrylonitrile (PAN) or rayon [Refs 1,2]. In the production of these textiles, a great deal of chemical waste is produced, creating a large footprint that is a detriment to the environment. This often limits locations for carbon fiber production and U.S.-based access, and drives costs due to increased demand. The supplier base is relatively small and consists of fewer than five companies, which [Ref 2] has led to an overburdened supply chain [Ref 3]. Additionally, the advanced organic textile used in producing carbon fiber is sourced from overseas, where a sudden loss of supply would significantly disrupt DoD and other defense-related programs [Ref 3]. Despite the fragility of the supply chain, the carbon fiber market is estimated to be USD $6.5B in 2022 and $21.7B in 2032, where over 40% of the industrial value is tied to the aerospace or defense market [Ref 2]. There is a potential gap of over 55,000 metric tons by 2026 where it would take several years to add additional capacity [Ref 2]. Sustainable alternative methods to producing these base level textiles would expand market level availability and drive cost margins for the Hypersonics and carbon fiber industry.

This SBIR topic looks for novel approaches that address scalability using the principles of green or sustainable chemistry to reduce waste products and ensure EPA compliance in the production of advanced organic textiles for carbon fiber production. Green chemistry is a field devoted to sustainability and forms a framework of twelve principles: prevent waste, atom economy, less hazardous synthesis, design benign chemicals, benign solvents and auxiliaries, design for energy efficiency, use of renewable feedstocks, reduce derivative, catalysis, design for degradation, real-time analysis for pollution prevention, and inherently benign chemistry for accident prevention [Ref 4]. Some of the toxic and hazardous waste products produced from current processes include, but are not limited to, HCN, NH_3, CO_2, CS_2, and H_2S [Ref 5].

Work produced in Phase II may become classified. Note: The prospective contractor(s) must be U.S. owned and operated with no foreign influence as defined by 32 U.S.C. § 2004.20 et seq., National Industrial Security Program Executive Agent and Operating Manual, unless acceptable mitigating procedures can and have been implemented and approved by the Defense Counterintelligence and

Security Agency (DCSA) formerly Defense Security Service (DSS). The selected contractor must be able to acquire and maintain a secret level facility and Personnel Security Clearances. This will allow contractor personnel to perform on advanced phases of this project as set forth by DCSA and SSP in order to gain access to classified information pertaining to the national defense of the United States and its allies; this will be an inherent requirement. The selected company will be required to safeguard classified material during the advanced phases of this contract IAW the National Industrial Security Program Operating Manual (NISPOM), which can be found at Title 32, Part 2004.20 of the Code of Federal Regulations.

PHASE I: Develop a proof of concept for a sustainable, repeatable chemical process that yields advanced organic textile fibers for the production of carbon fiber with comparable thermomechanical properties to existing textiles for TPS applications in hypersonic environments. Provide materials thermomechanical characterization analysis, including, but not limited to, density, moisture content, and break strength of the advanced organic textile. Demonstrate that this process could result in a reduction of toxic and hazardous waste and volatile compounds. Provide a detailed plan for full scale production of the advanced organic textile.

The Phase I Option, if exercised, will include the initial design specification and capabilities to build a prototype solution in Phase II.

PHASE II: Mature the process by testing the appreciability of the conversion of advanced organic textiles to carbon fiber. Provide materials thermomechanical characterization analysis, including, but not limited to, char yield, density, moisture content, and break strength after carbonization. Demonstrate the feasibility of production through processing the advanced organic textiles through a carbon fiber conversion process, either traditional or novel.
It is probable that the work under this effort will be classified under Phase II (see Description section for details).

PHASE III DUAL USE APPLICATIONS: If the demonstration in Phase II is deemed to be of high interest to the Government, support the Government in transitioning the technology for Government use. Ensure that the transitioned product is able to support current and future weapon and space systems, as well as a wide range of other air-, land-, and sea-based systems. Continue to scale the green/sustainable chemistry process to enable the continuous production of advanced organic textiles for carbon fiber production based on the prototypes developed in Phase II. Integrate the converted carbon fiber into a woven part to be “thermomechanically” characterized.
Integrate the technology into a flight experiment to validate the efficacy of the produced carbon-based TPS part. Carbon fiber is used in commercial space applications as well as many Navy/DoD components, such as Navy Strategic Systems Programs (SSP), Navy Conventional Prompt Strike (CPS), and Primes developing TPS. Sustainable, green chemistry-developed advanced organic textiles would be of interest to the aforementioned programs.
This project should transition to defense contractors for high-speed weapons and space systems.

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KEYWORDS: Green Chemistry; Sustainable Chemistry; Carbon Conversion; Hypersonics; Textiles; Thermal Protection Systems; Rayon and Polyacrylonitrile Carbon Fiber; PAN